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UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 621
Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief

Washington, D. C. PROFESSIONAL PAPER. February 16, 1918

THE CROW AND ITS RELATION TO MAN

By

E. R. KALMBACH, Assistant Biologist

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THE COMMON CROW (CORVUS BRACHYRHYNCHOS).

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INTRODUCTION.

Since the publication in 1895 of "The Common Crow of the United States"[1] no comprehensive treatise on the economic status of the crow has appeared. The edition of that bulletin has long since been exhausted, and the only recent publications available for inquirers have been short articles on the crow appearing in papers dealing with a number of birds.[2] In response to the many urgent requests for information for a number of years a complete investigation of the food habits of the crow was undertaken, and this paper is the result. As the former bulletin was based on an examination of the food of only 909 crows, collected mainly in eastern States, it was apparent that the number would have to be supplemented by material from other parts, especially the Middle West, before fair judgment could be passed. A campaign with this object in view was inaugurated, with the result that 2,118 stomachs of crows, both old and young, became available for this investigation. Effort was made also, by means of over 3,000 letters of inquiry, to secure reliable information as to the good or harm done by the crow, based on actual field observation. The data obtained have made it possible to present considerable trustworthy testimony which distinctly reflects present conditions. The quantity and character of the combined evidence thus secured seems sufficient to justify a final conclusion as to the economic status of the crow in this country.[1]

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[1] Barrows, W. B., and Schwarz, E. A., Bull. No. 6, Div. of Ornithology and Mammalogy, U. S. Dept. Agr., 1895.

[2] Notably Farmers' Bulletins 54, pp. 15–17, 1897 (revised edition pp. 22–23, 1904); 630, pp. 17–19, 1915; and 755, pp. 17–19, 1916.

Note.—This bulletin discusses in detail the beneficial and harmful food habits of the crow; gives a general account of its life history and geographic distribution; and shows how it may be controlled where necessary. It is for general distribution.

It is doubtful whether a study of the food habits of any other North American bird involves as many intricate problems as that of the crow. Practically omnivorous, the bird is capable of surviving in widely diversified environments. In its diet may be found everything from the choicest poultry and the tenderest shoots of sprouting grain to carrion and weed seeds, many of which at best offer but a morsel of nourishment. The fact that no less than 656 specifically different items have been identified in the stomachs examined gives some idea of the bird's resourcefulness, its potentialities for good or harm, and the complexity of the problem of determining its worth. Popular opinion also, often based on years of intimate experience, is by no means uniform. Many complaints against the bird are well-nigh traditional, while some of its beneficial habits have been matters of common knowledge for generations. Thus irreconcilable differences of opinion may exist among residents of even the same community. And by no means of one mind are those persons who have studied the bird from a strictly scientific standpoint. The writer, however, feels that the abundant evidence before him has been carefully and impartially weighed and asks indulgence of those who may discover that the process of reasoning from these data is at variance with their own.

SYSTEMATIC POSITION AND DISTRIBUTION OF THE CROW.

Notwithstanding the fact that to the average farmer in eastern United States the crow (Pl. I) is the most familiar of birds, and one would hardly suppose that there could be any ambiguity in the use of the term "crow," there is considerable uncertainty as to identification in regions where the bird is scarce or where its range overlaps that of closely related species. Ordinarily little distinction is made by residents of the South Atlantic coast between the common crow and the fish crow, a bird of quite different habits; and similar confusion exists among nonornithologists of the northwestern coast, where the other maritime form, the northwestern crow, mingles with the common species. In the Southwest the small white-necked raven frequently passes under the appellation of crow, and in some other parts of the West even the larger ravens have been misnamed.

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[1] Much of the information and material upon which this bulletin is based was acquired through the kind assistance of persons who volunteered their services. As they are too numerous to mention individually, the writer is compelled to express his appreciation for their help collectively. Without their aid very little information would have been available on the extent of damage to crops and the efficiency of protective measures. Further, without the assistance of specialists in various fields, to whom also the writer is greatly indebted, many problems arising in the examination of stomachs would have remained unsolved.

Inasmuch as it is contemplated eventually to issue reports on the economic status of all members of the genus *Corvus*, which includes both crows and ravens, it seems well to define clearly the systematic position and range of the common crow, the one of which this bulletin treats. Eleven subspecifically different forms of the genus *Corvus* have been recorded from North America and Greenland. The ranges of nine of these come within the borders of the United States. The other two forms are the rook (*Corvus frugilegus* Linnæus) and the hooded crow (*Corvus cornix* Linnæus), both of which have occurred in Greenland. Of the ravens three are found in the United States. The northern raven (*Corvus corax principalis* Ridgway), a more or less arctic race, occurs along the northern border and at the higher altitudes, while the common raven (*C. c. sinuatus* Wagler) is a more abundant form in the Western States. The white-necked raven (*C. cryptoleucus* Couch) occupies part of the southwestern desert regions. By far the most numerous species of this genus in the United States is the common crow (*Corvus brachyrhynchos brachyrhynchos* Brehm), which, with the three closely related subspecies, the Florida crow (*C. b. pascuus* Coues), the southern crow (*C. b. paulus* Howell),[1] and the western crow (*C. b. hesperis* Ridgway), gives practically a transcontinental range to the species. *Corvus b. brachyrhynchos* Brehm extends its breeding range northward nearly to the mouth of the Mackenzie River, northern Manitoba, central Quebec, and Newfoundland. It may be found from the Atlantic coast westward to Montana, Wyoming, central Nebraska, Kansas, and Texas. The limit of its range on the west, however, can not be stated satisfactorily, as in the western part of the Plains the crow is merely a rare and erratic breeder. The western crow (*C. b. hesperis* Ridgway) is found in the Pacific Coast States and eastward to eastern British Columbia, Montana, and Texas. The southern crow (*C. b. paulus* Howell) has a range extending throughout the Gulf States east of central Texas and northward as far as the

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[1] Proc. Biol. Soc., Washington, XXVI, pp. 199–202, Oct. 23, 1913.

District of Columbia and southern Illinois. The Florida crow (*C. b. pascuus* Coues) has a limited range throughout peninsular Florida. The two remaining species of the genus *Corvus* are the maritime forms, the fish crow (*Corvus ossifragus* Wilson) and the northwestern crow (*Corvus caurinus* Baird). The former is restricted to the Atlantic seacoast from Long Island south to Florida and westward along the Gulf coast to Texas; while the latter occupies the northwest coastal region from Puget Sound to southern Alaska.

In this bulletin the name "crow" has been used to cover the four subspecifically different forms recognized under *Corvus brachyrhynchos.* The food habits of these subspecies are essentially the same, varying only to the extent naturally occasioned by the varying character of the food supply in the different parts of an area as great as that covered by their combined ranges. In some of the Western States where the crow appears only as an occasional breeder it has but little economic significance. Among such areas may be mentioned all of Nevada, the greater parts of Arizona, New Mexico, Colorado, Wyoming, Utah, and Idaho, and eastern Washington and Oregon. The bird is only locally abundant in California. The western parts of Texas, Oklahoma, Kansas, and Nebraska support very few crows, while Montana, North Dakota, and South Dakota, as well as the Gulf States of Florida, Alabama, Mississippi, and Louisiana, embrace large areas where crows are not common.

A consideration of the economic value of the crow in the United States, judging from the average yearly abundance, may therefore be confined principally to the States along the Atlantic slope of the Appalachians and those in the central and upper Mississippi Valley. In the former area the States south of Virginia are less abundantly supplied with these birds during the breeding season than those to the north, while in winter the States of North Dakota, South Dakota, Minnesota, and the northern parts of Wisconsin, Michigan, and Maine harbor but few.

LIFE HISTORY.

A brief statement of the life history of the crow is necessary if its varied activities at different seasons of the year are to be appreciated and if the significance of its change of food habits from month to month is to be understood. A clear understanding of the breeding habits of the crow is essential also to a correct interpretation of the food habits of the young; and scarcely less important in this connection is the problem of the bird's migration and roosting habits in the colder months, when the normal crow population of certain sections is swelled manyfold by countless hordes from the north.

In presenting part of this information the writer can do no better than quote from Bendire:[1]

> Nest building in the more southern States begins sometimes by February 20, and correspondingly later northward. In the vicinity of Washington, District of Columbia, fresh eggs may be occasionally found in the last week in March, but more frequently during the first two weeks in April. Along our northern border they nest generally about the beginning of May; and even in the most northern portions of their range they have been known to breed equally early, but most frequently nidification here is protracted well into June. In Idaho, Washington, and Oregon it is at its height between April 15 and May 20. The nests are bulky, usually well constructed, and placed in the forks of branches, generally well up and hard to reach. Occasionally one is placed near the main trunk, this being mostly the case where bushy cedars or junipers are used. Any sort of tree may be chosen for a nesting site, providing it is one of dense foliage, which will hide the nest well. In some localities pine trees seem to be preferred, while in others oaks are often selected. In the West cottonwoods, junipers, and willows are most frequently used. Nests are usually placed at heights varying from 20 to 60 feet; but I have found some barely 6 feet from the ground, and in many localities in the West they are rarely placed over 20 feet up. Here also they are said to occasionally nest on the ground, but I have never observed this personally. Crows rarely nest in deep forests, the borders of woods and the river bottoms being preferred for such purposes. The nests are composed outwardly of sticks, weed stalks, corn husks, and other coarse material, and lined with grapevine bark, fine roots, dry grass, leaves, straw, moss, rags, wool, and hair, the lining varying in different localities. Where cattle are plenty the nests are often found lined with more or less of their hair. These finer materials are well quilted together. The outer diameter of the nest is usually about 24 inches by 9 inches in depth. The inner cup is from 4 to 6 inches deep and from 12 to 15 inches in diameter. This prevents the eggs from being thrown out of the nest during high winds when placed in slender branches in the extreme tops of trees.
>
> The number of eggs to a set varies from four to eight. Sets of five are most commonly found, while those of seven are rare, and those of eight quite unusual. Mr. A. C. Kempton, Wolfville, Nova Scotia, writes me that he found a set of ten eggs in the spring of 1890, which he believes were laid by the same bird. In the Western States usually from three to five eggs constitute a set, and those of six, according to my observations, are much rarer than in the East. Incubation lasts about eighteen days, and both parents assist in this duty. The young are born blind and naked, and remain in the nest about three weeks. While crows steal many of the eggs of other birds, they apparently do not molest any of their own kind, but if several pairs nest close together they will steal nesting material from each other whenever an opportunity occurs. The old nests are resorted to for several seasons in succession where not molested. Only one brood is raised in a season; if the first eggs are taken, they usually lay a second set, but rarely in the same nest. When the young are nearly fledged, they may often be seen sitting on the rim of the nest or on branches close by, watching for the return of the parents with food, and keeping up an incessant clamor.

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[1] Bendire, Charles, Life Histories of North American Birds, II, pp. 411–412; Special Bulletin, U. S. Nat. Mus., 1895.

THE ROOSTING HABIT.[1]

While crows, even in the nesting season, are more or less clannish, their gregarious habit is most highly developed during the colder months. Soon after the nesting season one may expect to see evidences of it, but in the latitude of Washington, D. C., roosts are not well established until the end of September. At this time their migratory habits have brought together in a comparatively small area the bulk of the crow population of North America, so that the area lying between the thirty-seventh and forty-second parallels of latitude—that is, from Connecticut to Virginia—and extending westward from the Atlantic coast to beyond the Mississippi River harbors these birds in extremely large numbers. Their roosts are occupied with considerable fluctuation in population until the advent of milder weather in March, when the numbers rapidly decrease.

A variety of situations, differing widely in the character of vegetation, are acceptable as sites for crow roosts. Pine and other evergreens are most frequently chosen, though records of crows passing the night in groves of deciduous trees, as oaks and maples, are common. A large roost in Crawford County, Kans., was in a heavy stand of catalpa. That crows roost among such low vegetation as reeds or tall grass has been noted, while in some cases even in severe weather the birds have been known to gather on the ground in open fields or on exposed sand bars.

Many attempts have been made to estimate the number of birds which gather at some of these roosts, but the daily fluctuation, caused by changes in weather and by birds stopping at some local roost when they have been overtaken by darkness, makes the computing of their number difficult and, in large measure, unsatisfactory. The wide variation of the estimates made by several observers at the same roost readily shows the uncertainty of results. Furthermore, the impression made upon a person not very familiar with the sight of the gathering thousands is quite likely to be an exaggerated one.

A roost at Arlington, Va., was supposed to contain at the height of its occupancy from 150,000 to 200,000 birds. These figures have been averaged from the records of a number of observers and may be regarded as reliable. The "Arbutus" roost, near Baltimore, contained in 1888, according to the account of Mr. C. L. Edwards,[2] a population of more than 200,000. The St. Louis roosts, about 1886, contained from 70,000 to 90,000 crows. One at Peru, Nebr., at the same time had 100,000 to 200,000. Other roosts numbering approximately 200,000 birds were recorded about the same year in New

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[1] More fully treated by the author in Winter Crow Roosts: Yearbook for 1915, U. S. Dept. Agr., pp. 83–100 (Sep. 659), 1916.

[2] Edwards, C. L., Amer. Journ. Psychol. I, No. 3, p. 454, May, 1888.

Jersey at Hainesport, Merchantville, Reedy Island in the Delaware River, Bridgeboro, and Centerton; and in Pennsylvania at Davis Grove and Camp Hill. Some of these roosts are still occupied and are said to harbor thousands of birds. A roost at Woodridge, near Langdon, D. C., which appeared to be the successor to that observed some years ago at Arlington, Va., is reported by A. H. Howell, of the Biological Survey, to have harbored 270,000 birds in the winter 1910–11. Mr. Howell estimated that fully 100 crows a second entered the roost at the height of the influx, and added that this would be 6,000 every minute, and if the same rate continued for three-quarters of an hour, which is about the time occupied by the gathering of the clans, 270,000 crows would be established for the night within an area of 5 to 10 acres. He says that while this estimate may be short of the actual number it certainly does not greatly exceed it. Dr. S. D. Judd observed this same roost in February, 1901, when he estimated 100,000 as its population.

A roost located near Chevy Chase, Md., considered to be the successor to the Woodridge roost, and one upon which the writer made observations, gave a much smaller number of birds. Observations made on January 8, 1911, under a line of flight coming from the east, indicated that from 1,800 to 1,900 birds flew past. The four lines of flight entering the roost would probably give a total population of about 7,500. A strong wind was blowing at right angles to the direction of flight, and as this caused the birds to spread out in a pathway fully half a mile wide doubtless many were overlooked. About the 1st of January, 1912, the crows forsook this roosting place, and, again resorting to the previous site near Woodridge, combined with a small number which had been using this place. The writer visited this roost on January 28, 1912, and estimated the number coming from the north at about 6,500. This would mean that the whole roost was occupied by probably from 25,000 to 30,000.

In response to letters of inquiry considerable information bearing on the location, size, and character of crow roosts occupied during the winter of 1911–12 was secured. Upward of 290 correspondents submitted reports of this nature, and while it can not be claimed that the data obtained are anything but a mere fragment of knowledge, the compilation of these facts sheds some light on the location of the winter crow population.

On the map on page 8 (fig. 1) is recorded a total of 170 roosts of varying size. This shows in what areas a rather restricted migratory movement has assembled a large part of the crow population of North America. East of the Appalachians and grouped on the lower watersheds of the Potomac, Susquehanna, Delaware, Hudson, and Connecticut Rivers are many of the most populous roosts, some of them reported to contain over 100,000 birds. Here the open water maintained by most of these streams throughout the winter and the extensive tidal flats within easy reach of these rendezvous assure the crows a fairly ample supply of food. In the Middle West a greater region of favorable winter habitat has permitted the birds to establish their roosts over a much broader area. As in the East, the winter crows of the Mississippi Valley have selected a district well supplied with their customary winter food. Here the roosts of greatest size are found in southern Indiana, central Illinois, and westward along the Missouri River, while eastern Kansas and northern Oklahoma also support vast numbers. During fall and early spring the northern States from Maine west to the Plains harbor many migrants, which form, at times, temporary roosts of considerable size. From December to the middle of February, however, the birds which frequent these States are comparatively few in number and their roosts seldom contain over a few hundred individuals. The more important of these may be found along the coast of Maine and in west-central New York, in the vicinity of Seneca and Cayuga Lakes. In the South the largest colonies are found along the Atlantic and Gulf coasts and are made up probably of birds resident in the Southern States which have congregated at favorable spots. Fish crows often form the bulk of the population of southern roosts, and in fact are common in colonies as far north as Maryland. On the Pacific coast, owing probably to the milder winter climate, the roosts are found at higher latitudes, the coastal region about Puget Sound being an area particularly well supplied.

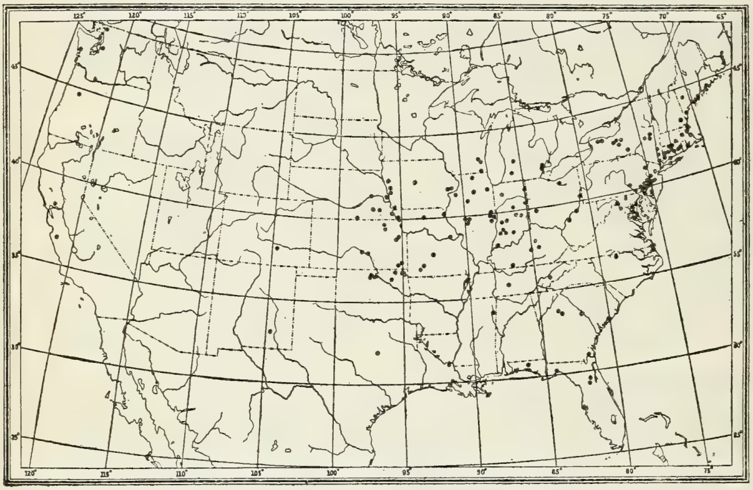

FIG. 1.—Map showing location of crow roosts known to have been occupied in the winter of 1911–12.

Ornithologically, aside from all economic considerations of good or harm arising from the gathering of immense numbers of crows, a winter crow roost must be regarded as one of the most wonderful of bird phenomena still existing in close proximity to large cities. In many instances the lines of flight pass daily over metropolitan districts during the winter months, yet only an extremely small proportion of the people realize their significance. In the immediate vicinity of the roosts the gathering of thousands of birds seldom fails to incite the latent instincts, so frequently present behind the shotgun, to kill for the mere sake of killing, regardless of whether the birds may be doing good or harm. The easy pot shot at hundreds of closely perched birds is a chance that few gunners seem able to resist. But the fact that these birds have maintained this interesting habit, even in the face of constant persecution over a period of many years, bids fair to insure its continuance as long as crows remain abundant.

Economically, the roosting habit is of considerable importance, inasmuch as it results in the gathering of thousands of individuals of a species possessing some harmful traits. Fortunately, the clans do not assemble for the purpose of feeding, but even as it is, large numbers of crows often forage together on comparatively small areas in the vicinity of roosts. Harm is then almost sure to be done to crops still in the field.

INFORMATION FROM CORRESPONDENTS.

While the examination of stomachs affords the most accurate means of determining the various food items that enter into a bird's diet, it frequently fails to give information on certain points essential to a complete consideration of the economic status of a species. This is especially true in the case of the crow. It is impossible in many instances to state with certainty whether the remains of a chicken, wild bird, or small mammal found in a stomach are indicative of the predacious activities of the crow or of its carrion-feeding habits. Neither is it possible to determine accurately what proportion of corn eaten has been stolen from the shock, "pulled" when sprouting, or picked up as waste grain. Financial losses to individual farmers, the efficiency of measures of crop protection and efforts toward the reduction of the number of these birds when found troublesome, and the perplexing complications sometimes arising about game farms and preserves are other important problems which can not be solved in the laboratory.

Fully cognizant of the shortcomings of a method of investigation depending entirely on stomach examination, the writer has relied to a considerable extent on the field observations of reputable ornithologists and the testimony of reliable farmers, game raisers, sportsmen, and others who have had intimate experience with the crow. For the purpose of securing such information a circular letter, including the following questions on various phases of the economic value of this bird, was prepared:

(1) Are there any crow roosts in your vicinity where the birds congregate in large numbers during the winter months? If so, describe them briefly, noting the approximate number of birds, acreage of the roosts, and characteristic vegetation.

(2) Is the crow numerous in your vicinity during spring and summer?

(3) Does it inflict serious damage upon corn, either when sprouting or when in the shock, and does it appear to be as troublesome in your locality as it was 15 years ago?

(4) Do farmers in your locality resort to the practice of tarring seed corn? If so, how successfully has it protected the crop?

(5) Do crows destroy much poultry and many eggs, and does the habit appear to be confined to a few individuals, or is it a more or less characteristic trait of all crows in your vicinity?

(6) To what extent can the reduction in numbers of our game birds, such as grouse and quail, and many smaller insectivorous species, be attributed to the crow?

(7) Has there been a bounty system on crows in force in your vicinity in recent years? If so, has it noticeably reduced the numbers of this bird?

Nearly 3,000 copies were mailed, the bulk on December 21, 1911. Since then numerous additional circulars have been distributed. Replies to the number of 909 were received, and much of the information thus obtained has been incorporated in this bulletin.

FOOD HABITS.

What the crow eats or does not eat is the first question to be answered in an inquiry into its economic status. To determine with accuracy the various food items entering into the diet, experience has shown no method more reliable than the microscopic examination of stomach contents, carefully conducted with the aid of extensive reference collections for comparison. Such a method of investigation, supplemented when necessary by field observation, was employed in the preparation of this bulletin.[1] The 2,118 stomachs examined were collected in 39 States, the District of Columbia, and several Canadian Provinces. Of these, 1,340 were of adults and 778 of nestlings. Table I shows the distribution of this material, the stomachs being classified under adults, nestlings, and the State and month in which collected.

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[1] For a list of items specifically or generically identified in the stomachs examined for this report, see pages 86 to 90.

TABLE I.—*Number of crow stomachs available for this investigation, arranged to show locality and month in which collected.*

State.	Adults.													Nestlings.			
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals by States.	April.	May.	June.	Totals by States.
Alabama	1	1	1	2	1			2	4	2		1	15	1			1
Arkansas						1							1				
California	1	2					1		1	1			6				
Canada	3	6	5	21	14	14	29	1	3	3	1		100		3		3
Connecticut	12	3		1	1	11				7	4	5	44				
Delaware							2						2				
District of Columbia	3	13	8	3	4	1			2	4	2	18	58	25	66	4	95
Florida	1	6	2	1		1				2			13				
Illinois	1		2	5	4	1	3	1		1	4	2	24		6		6
Indiana			1	1			6	3	8	1			20				
Iowa				1	4	5	3		3	1	2	1	20		9	3	12
Kansas	2	5		8	47	6	3	4	1	2	23	1	102	17	309	11	337
Kentucky			4	1						4			9				
Louisiana	6	3		2	2	1				2	1	2	19				
Maine				1	1	7	3						12			8	8
Maryland	7	12	14	3	51	44	16	7	10	1	5	29	199		146	15	161
Massachusetts	1	1	3	3	4	15	3			4	3		37			7	7
Michigan			11	5	6	5	2		3	2			34		29		29
Minnesota						2	2						4				
Mississippi						1			1		2		4				
Missouri				8	21	23			3				55	5	53	4	62
Montana			1					3					4				
Nebraska			1	1			1		3				6				
Nevada	1												1				
New Jersey	4	2	46	2			2		3	101			160				
New York		1	18	4	17	35	9	4	10	18	3	5	124		4	16	20
North Carolina	48												48				
North Dakota					2	2	1		3				8				
Ohio						6		5	1	14			26				
Oklahoma		1											1				
Oregon	5			1	2		2			1			11				
Pennsylvania	5	8	5	1		16	7	2					44			4	4
Rhode Island			1										1				
South Dakota				2					2				4				
Tennessee					1	1	1						3				
Texas	2		1								2	1	6				
Vermont					2					1			3		24	1	25
Virginia	20	4	1		3	3	1	5	1		2	6	46				
Washington									1				1				
Wisconsin	4	1	7	12	9	2	3	5	12	5	3	1	64		8		8
Wyoming					1								1				
Totals by months.	127	69	132	89	197	203	100	42	75	177	57	72	1,340	48	657	73	778

Total adults, 1,340. Total nestlings, 778. Grand total, 2,118.

FOOD OF ADULT CROWS.

ANIMAL FOOD.

Animal food forms only 28.14 per cent of the yearly sustenance of the adult crow, but economically it exceeds in importance the vegetable portion. The assumption that the crow is primarily carnivorous and that the vegetable matter eaten is taken more from necessity than choice appears to be correct. Much of the vegetable food is of no economic importance, while there is little of the animal portion that is not intimately connected with the interests of man. The greatest proportion of animal food is consumed in May (52.44 per cent). In the three months following a very uniform decrease is noted (46.98, 44.28, and 39.40), but even as late as September the animal portion constitutes nearly a third (32.32 per cent) of the food. Lower percentages from October to March, inclusive (14.29, 18.74, 13.18, 14.94, 10.97, and 16.05), reflect the struggle for existence which is the lot of the crow during the colder months. With April, however, comes relief, and the animal food again becomes conspicuous (34.09 per cent).

INSECTS.

In passing judgment on the economic value of most birds, nothing is of greater importance than a thorough understanding of their insect food. By this it is not meant merely that one should know the noxious forms eaten, the destruction of which is a benefit to man, but cognizance must also be taken of the complex relations between the various beneficial (predacious and parasitic) insects destroyed and the injurious ones upon which the bird commonly feeds. Some of this information is as yet unavailable, owing to the lack of knowledge of the interrelations between insect forms. Enough has been learned of the crow, however, by examination of 2,118 stomachs, 1,340 of which were of adults, and by reliable field observations to make possible the assertion that, for all practical purposes, sound judgment on the merits of the insect-feeding habits of the crow can be given. The series of stomachs available is sufficiently large and was collected under the varying environments of so many localities that the results obtained are probably close to a true average for the area in which the crow is common.

Insect food was taken by adult crows in every month of the year, though in January it amounted to only 1.29 per cent. February was represented by 4.85 per cent; March, 4.58; April, 14.72; May, 39.77; June, 35.95; July, 33.85; August, 35.07; September, 27.64; October, 11.51; November, 14.16; and December, 4.49. The insects identified belong to 12 orders, embracing no less than 455 specifically distinct forms. A discussion of this part of the crow's food will be taken up, order by order—Coleoptera (beetles), the order best represented in the crow's diet (7.58 per cent of the yearly food), being treated first.

Coleoptera (beetles).

The crow is primarily a terrestrial feeder. Its quota of beetles, therefore, is made up almost exclusively of species found on or near the ground, or those which, by the turning over of sticks, clods of earth, or dung, are secured from beneath the surface. The latter is a common method of feeding employed diligently by the crow from early spring to the beginning of autumn, when the usual crop of grasshoppers furnishes a more accessible supply of food.

SCARABÆIDÆ (May beetles, white grubs, June "bugs," rose chafers, tumblebugs, etc.).—Of the beetles, the Scarabæidæ are most important, forming 4.28 per cent of the annual food. Of these, May beetles (*Phyllophaga*) and their larvæ, white grubs, constitute by far the largest portion. Reference to the chart on page 42 will show that the area representing the amount of scarabæid beetles eaten practically coincides with the period of abundance of adult May beetles. These beetles, which at times entirely defoliate trees and shrubs and as larvæ extensively injure grass lands, corn, and other crops, are a particularly favorite food of the crow. Twenty-one species were identified in the material from crow's stomachs, a fact which in itself is indicative of the persistence with which these birds hunt. The percentages amount to little during the first three months of the year, but an indication of the year's brood is seen in April, when nearly 5 per cent is recorded. Then come May (the height of the May beetle season) with nearly 21 per cent; June with 10.06; and July and August with about half that amount. One hundred and fifty-six of the 197 adult crows collected in May had fed on these insects. Two birds had eaten nothing else, while several stomachs contained over 90 per cent of this food. In many cases the remains of these beetles were in advanced stages of digestion and formed but a small proportion of the stomach contents, but nevertheless they furnish striking evidence of the number of May beetles that crows are capable of destroying. Of course, such insect fragments are frequently the accumulated débris of several previous meals, but, when it is remembered that birds fill and empty their stomachs several times a day, the work the crow does upon May beetles is of the greatest importance. A female collected April 23 in Dallas County, Mo., had picked up 85 of these beetles, which, together with two other scarabæids, formed 42 per cent of the food. Two birds taken in the middle of May at Onaga, Kans., had eaten 29 and 28 respectively. One secured in Kentucky as early as March 31 had devoured 27 of these pests, while no fewer than 22 other adult crows had eaten 10 or more apiece.

Though crows are generally recognized as one of the important enemies of the white grub, the larva of the May beetle, it happens that the nestlings consume many more than the adult birds (see page 57), a circumstance logically accounted for, as the parent birds feed the more succulent food to their offspring. Of a total of 1,340 adult birds only 55, or 1 out of every 24, had fed on the larvæ of scarabæid beetles. These may not all have been of the genus *Phyllophaga*, as the identification of the remains of these grubs is often difficult owing to the rapidity with which they are digested. An adult crow collected in Manitoba in May had eaten 45 grubs along with fragments of adult *Phyllophaga*, the whole forming 70 per cent of the food. One from Kansas secured at the end of April had made away with 17 grubs and 3 adults; and another, collected in North Carolina in January, gave evidence that in warmer climates where they do not burrow deeply in winter, these larvæ are preyed on the year round. This bird had eaten 17.

The stomachs examined show conclusively that the crow is a most effective enemy of the May beetle, especially in the adult form. Field observations have verified this conclusion repeatedly and have furnished many striking instances of the value of this bird during outbreaks of the insects.

Norman Criddle, of Aweme, Manitoba, who has observed the habits of these birds for many years in the Northwest, stated in a letter to the Biological Survey that crows—

> have also been observed here to collect practically every white grub [*Phyllophaga* sp.] thrown up by the plow on fields covering many acres. (1911.)

Benj. F. Gault, of Glenellyn, Ill., reports:

> Grass plots, both lawn and timothy, infested by these pests, I have known, on two marked occasions, to have been gone at most rigorously by them, the sod being torn up yards square in extent as thoroughly almost as though a pack of hogs had undertaken to do the work instead. (1912.)

H. W. Tinkham, of Fall River, Mass., in reporting his observations, presents evidence to show a source of supply of which the crow may take advantage:

> One crow picked up 47 May beetles on Sunday morning in the street in front of my house, and, as I had a powerful glass on him, I was much interested in his method. He would break the wing covers off, and, I think, the head, then gather a few, say four to six, into a pile, take two or three into the back part of the mouth and run his bill like a skewer through the balance. He made several trips to gather the 47—I think 8. (1901.)

Many species of these beetles are attracted at night to lights along roadways, fall to the hard pavements, and are unable to hide at the approach of daylight. Others may drop to the ground from the foliage of overhanging trees where they had been feeding during the night. Many also fall into the water of lakes and streams, where they are drowned, washed ashore, and there picked up by the crow; and still others, having bred, die from one cause or other, and may be found almost anywhere. Some of the May beetles in the stomachs of crows doubtless were dead when picked up, and in feeding on them no particular service was rendered, but enough is known of the methods pursued by these birds in their search for food to demonstrate that it is the living beetle, hid under sticks, stones, and clods of earth for which they search.

In view of the fact that white grubs frequently inflict serious damage on crops in spite of most vigorous efforts to control them, it is important that all their natural enemies be permitted to continue their work unmolested. Among the most important of these is the crow. Before condemning these birds when found feeding in cornfields and grass lands, especially during the breeding season, it will be well to investigate the reason for their presence. The "corn-pulling" crow frequently has his gizzard filled with the insect enemies of this grain, a fact learned, often with considerable surprise, by many a farmer who, though skeptical, has been induced to open and observe the stomach of one of these birds shot in the cornfield.

The carrot beetle (*Ligyrus gibbosus*) and others of the same genus are eaten in considerable numbers. In contrast to May beetles, these insects inflict the greatest damage when in the adult stage, their larvæ feeding merely on decaying vegetation. Four crows collected in Dallas County, Mo., had secured 22, 21, 18, and 15 carrot beetles, respectively, and in several other cases these insects constituted over half the stomach contents. A closely related beetle (*Dyscinetus trachypygus*), found in wet situations, was eaten on several occasions. A particularly interesting case was that of a crow shot near the surf on Wallops Island, Va., which had eaten 36 of these beetles. Apparently the insects were present in great numbers (possibly dead ones washed in by the surf), as this bird, ignoring the harder parts, satisfied his appetite by merely snipping off the soft abdomens. No heads, thoraces, nor front legs, and only one wing cover, and a few middle legs were found. The hind legs and abdomens present furnished the evidence of the number eaten.

When opportunity presents itself, June bugs (*Cotinis nitida*) are taken freely by the adult crow, though the number of actual records of such work is not large. At least 20 were found in the stomach of one crow collected in Virginia in July. Another had eaten 19, and a third, 17. Euphorias, destructive beetles with habits similar to those of June bugs, are captured more frequently. The Indian euphoria (*Euphoria inda*) occasionally injurious to ripening fruits, especially peaches and pears, was fed to nestlings on numerous occasions, but the most noteworthy record among adult birds was that of one collected in Massachusetts in May, which had eaten 9. Two other species, *E. fulgida* and *E. sepulchralis*, also were identified. Vine-chafers, members of the genus *Anomala*, occurred in a number of stomachs, 20 individuals being found in one. Other phytophagous scarabæids were found, but in no case were insects of economic importance eaten in large numbers. Among these may be mentioned the goldsmith beetle (*Cotalpa lanigera*), the spotted vine-chafer (*Pelidnota punctata*), and the hermit flower-beetle (*Osmoderma eremicola*).

The dung-inhabiting scarabæids (Laparosticti) are common items of the crow's diet. The bird's habit of turning over and searching under cow dung brings him in intimate contact with small dung beetles of the genus *Aphodius*, so abundant in spring and fall. The function of most of these beetles is that of scavengers, though one species, *A. granarius*, has been known to feed on and injure corn. A crow collected in California in February had eaten 50 of these. In view of their abundance, it is not surprising that upward of a score of these small beetles were frequently found in single stomachs. Members of the genus *Atœnius*, which live in rich earth, appeared less frequently than *Aphodius*. Tumblebugs (*Canthon* and *Geotrupes*) often form a considerable portion of the stomach contents, and associated with them frequently are the remains of other scavengers, *Copris*, *Onthophagus*, or the brilliantly colored *Phanœus carnifex*. While it can not be said that the crow is aiding man by consuming the scavenger scarabæids, unless it be in case of some species possessing herbivorous habits, as *Aphodius granarius*, it is doubtful whether it is doing serious harm. Feeding on these beetles may well be considered to have a neutral effect.

CARABIDÆ (ground beetles).—Only recently has anything like a fair value of predacious beetles been recognized, and economic entomologists are depending more and more on them in battling with insect pests. A most striking example of the effective work of predacious carabids is found in the activities of the larva of the imported *Calosoma sycophanta*, a foe of the gipsy moth in New England. When it is considered that carabid beetles, including members of such a highly beneficial genus as *Calosoma*, are frequently eaten by crows, a study of this portion of the food becomes of the utmost importance. It must be borne in mind, however, that certain ground beetles, as *Agonoderus pallipes* and a few members of the genera *Amara* and *Anisodactylus*, to some extent are herbivorous and have been known to do appreciable damage.

Ground beetles constituted 1.56 per cent of the yearly food of the adult crows examined, the bulk of these insects being taken in the months from April to September. May, with 5.54 per cent, was the month of greatest consumption, and June, with 3.24, stands next. In the fall and winter months these beetles did not form so much as 1 per cent of the food. Reference to the tabulation on page 43 will show that the monthly percentages of these insects eaten well represent their relative abundance at different seasons of the year. While fragments of carabids were found in a great number of stomachs, only rarely did they occur in numbers or constitute a large proportion of the food, the exceptional stomachs coming mainly from the West, where many of the smaller and apparently herbivorous species are extremely common.

The caterpillar hunters (*Calosoma* spp.) are probably the most conspicuous and valuable carabids eaten by the crow. Both adults and larvæ are inveterate enemies of caterpillars, some species even climbing trees in search of their prey. The offensive odor and supposed warning coloration, especially of *C. scrutator*, *C. willcoxi*, and *C. calidum*, appear to have no deterring effect upon the crow, the nestlings of which ate even greater numbers than the parent birds. The brilliantly colored *C. scrutator* was identified in 16 stomachs of adults, six being the largest number found in any one stomach. The fiery hunter (*C. calidum*) was eaten more frequently, being present in 53 of the 1,340 stomachs. In one stomach, that of a bird collected in New York in June, were the remains of at least 15 of these beetles, forming half the bird's food. Another crow from New York had taken 10, and one from Manitoba, 5. Four other species of *Calosoma* were identified, but in none of the stomachs did they occur in large numbers.

Beetles of the less common genera *Carabus* and *Cychrus* were found in correspondingly fewer stomachs. The large, broad ground beetle *Pasimachus*, so common in some of the prairie regions of the West, was a regular article of food of crows collected in Kansas. One of these taken in May had eaten 16, while another secured in Illinois in November had devoured no less than 80 of the larvæ. Of the 1,340 adult crows, 57 had fed on *Pasimachus*. Both the larger and smaller *Scarites* (*S. substriatus* and *S. subterraneus*) were found, though seldom more than one to a stomach. Of the smaller active ground beetles with predacious habits those of the genus *Pterostichus* appeared most frequently, but never in large numbers. *Evarthrus* appeared in numerous stomachs from Kansas. Various species of *Harpalus* also were well represented, especially the large *H. caliginosus*, and *H. pennsylvanicus*, one of the commonest of the genus.

The extreme abundance of members of the genus *Amara* in some sections of the West would seem to indicate that they are more herbivorous than is generally supposed. A crow collected at Aweme, Manitoba, in May had eaten no less than 176, along with several *Harpalus;* another taken in April made away with 131 *Amara*, 6 *Platynus*, and fragments of a few other ground beetles; and a third had its stomach nearly half filled with the remains of 91 *Amara*, 57 *Harpalus*, and 2 *Calosoma calidum*. Several other stomachs collected in the Northwest contained upward of a score of these small beetles. Ground beetles of the genus *Chlænius*, insects which frequent damp situations, occurred in a number of the stomachs of Kansas crows. *Agonoderus pallipes*, which is at times destructive to seed corn, was present in only a few.

In the destruction of predacious ground beetles, especially the larger ones, as *Calosoma* and *Pasimachus*, the crow is doing man indirect harm. Fortunately the quantity of such food is small, only

1.56 per cent of the yearly food. This is somewhat atoned for by the presence in the diet of certain apparently herbivorous carabids.

RHYNCHOPHORA (weevils, billbugs).—In the control of weevil pests as a whole, the crow can not be considered an important factor. These insects form only 0.59 per cent of its food and on only two species does the bird feed to an extent sufficient for it to be considered even a moderate check on the increase of the insects. These are the clover-leaf weevil (*Hypera punctata*) and the imbricated snout-beetle (*Epicœrus imbricatus*). The former, introduced from Europe many years ago, has gradually extended its range until it is now reported doing serious damage as far west as Idaho.[1] Of the stomachs examined, 107 contained remains of the clover-leaf weevil, an average of about 1 for every 12½ stomachs. Eleven was the largest number recorded in any one stomach, that being of a crow collected in New Jersey in March. The imbricated snout-beetle which is known to injure a variety of crops, was found in fewer stomachs (68), but in several instances in considerable numbers. A series of four stomachs secured at Sandy Spring, Md., in May contained 27, 25, 14, and 11, respectively. Clover-root curculios (*Sitona*), rhubarb curculios (*Lixus concavus*), and other species of *Lixus* occurred in a limited number of stomachs. Members of the genus *Thecesternus* were taken frequently by crows collected in the central and southern parts of the Mississippi Valley. Billbugs, including pests which feed to an injurious extent upon corn, small grains, and grasses, also entered into the crow's diet.

OTHER COLEOPTERA.—Other miscellaneous beetles comprised nearly 1 per cent of the crow's annual food. Common among these were the necrophagous and coprophagous forms, Silphidæ, Staphylinidæ, and Histeridæ. These beetles were taken about as frequently as scarabæids of similar habits and often appeared in the same stomachs. Their presence in the crow's diet is indicative of the bird's scavenger habits, and it would appear that on occasions the crow will search through carrion merely for these insects, leaving the offal as convenient bait for more. The larvæ of these beetles are taken as well. A crow secured in Alabama in May had fed on at least 29 larvæ of a *Silpha*. Another from New York had eaten 13. One shot in Dallas County, Mo., in June had devoured no less than 21 adults of the large staphylinid *Creophilus villosus*, as well as 3 of a species of *Necrophorus* and 9 of *Silpha surinamensis*, which together, forming 55 per cent of the food, lent strong circumstantial evidence as to the nature of the remains of a chicken and turtle found in the same stomach. Of larder beetles (Dermestidæ) the crow eats few. Histeridæ, small, shiny, hard-shelled beetles that live in carrion and probably feed on other insects found there, were present in a number of stomachs, though never forming a large part of the food.

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[1] Parks, T. H., Journ. Econ. Entom., VII, No. 3, p. 297, 1914.

Click beetles (Elateridæ) or their larvæ, wireworms, were present in 105 stomachs. In no month of the year, however, did these destructive insects form as much as 1 per cent of the crow's food. A bird taken at Aweme, Manitoba, in May had destroyed 72 wireworms and 1 click beetle. Mr. Stuart Criddle, who collected this bird, noted at the time it was shot that "wireworm beetles were all over the fields, and that the crows could be seen turning up cow dung, sods, and bits of sticks hunting for them." (1912.)

The late Prof. F. M. Webster, in writing of the natural enemies of wireworms, made the following statement:[1]

> Among the natural enemies the crow is doubtless the most useful, and what testimony we have on the subject goes to show that elaters and their larvæ constitute a large portion of its food. B. F. Aston, of White Creek, N. Y., on breaking up a crow's nest containing the unfledged young, found the crops of each of these to contain 70 or 80 snapping beetles. A more recent observation is recorded by Prof. Theo. G. Lemmon, of Westport, Mo., in a paper read before the State Horticultural Society at its twenty-ninth annual meeting. The professor shot and examined the contents of the crops of a number of crows about Lexington, Mo., where the ravages of wireworms had been very severe, and found that they contained a sufficient number of these insects to warrant the assurance that the crow is the untiring enemy of the wireworm.

From such reports it would appear that the crow is a more effective enemy of the wireworm than stomach examination indicates. It doubtless does good work during outbreaks of these insects, and were it possible to collect material under such circumstances much positive evidence of this trait could be secured.

A few long-horned and metallic wood-boring beetles (Cerambycidæ and Buprestidæ), stag beetles (Lucanidæ), leaf beetles (Chrysomelidæ), aquatic beetles (Dytiscidæ and Hydrophilidæ), and darkling beetles (Tenebrionidæ) also enter into the crow's diet, but in no case is their destruction of great importance. Beetles of small size are practically immune to the attack of crows. A single ladybird (*Megilla maculata*), for instance, is the only one of this fairly abundant family found in the entire series of 2,118 stomachs. The smaller species of leaf beetles also were lacking, though abundant and available in many of the situations in which the crow habitually feeds.

Orthoptera (grasshoppers, locusts, and crickets).

In many respects Orthoptera constitute the most important insect food of the crow. In bulk they are exceeded by beetles by only a fraction of 1 per cent, while the damage they inflict far exceeds that done by the heterogeneous assortment of beetles eaten. The most serious insect plagues of history have been of grasshoopers and crickets, and in some of the Western States the ravages of the migratory species are matters of but yesterday. While the extremely serious outbreaks of early pioneer days may not be repeated, owing to man's encroachment and modification of the breeding range of these insects, the annual losses due to them throughout the country are nevertheless great.

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[1] Ohio Agr. Exp. Sta., Bull. 46, p. 228, 1893.

The crow's yearly consumption of Orthoptera (most of which are Acrididæ, the short-horned grasshoppers) amounts to 7.34 per cent of the food, the bulk of which is taken during the latter half of the year. It is not until May that these insects enter strongly into the diet (4.29 per cent). June follows with 5.83 per cent, and then, in the increased amount of this food for July (14.04 per cent), is seen the arrival of the regular summer crop of these pests. August and September are represented with even greater quantities (19.14 and 19.24), and the decrease of the insects in October, November, and December is recorded rather irregularly by the percentages of 8.68, 10.73, and 2.07, respectively.

ACRIDIDÆ (short-horned grasshoppers, locusts).—The short-horned grasshoppers, or locusts as they are more familiarly known in those sections where, as migratory hordes, they inflict severe damage, constitute by far the greater part of the Orthoptera eaten by the crow. The percentages quoted above for the whole order may well be considered representative of this particular family. Of the 1,340 adult crows, 589 had partaken of grasshoppers. Some stomachs contained only a jaw or leg fragment, estimated as merely a "trace," while others were filled exclusively with the insects, in some cases over a hundred individuals being counted. Inasmuch as a bird's stomach frequently contains the indigestible parts of several previous meals, the large numbers obtained by counting grasshopper jaws is not so surprising. At the same time, when it is considered that an adult crow will eat enough in the course of a day to fill its stomach completely several times, the extent of its destruction of grasshoppers becomes apparent. The nestlings, which require still larger quantities of food for their rapidly growing bodies, are of even greater value in regions where these insects are plentiful (see p. 59).

An adult crow, secured in Indiana in August, had eaten no less than 123 grasshoppers, these forming over two-thirds of the food. One taken in Maine in May had picked up 108 of a little "grouse locust" (*Tettigidea* sp.). These chunky little grasshoppers pass the winter in the imago or adult stage and early in spring are often found abroad in considerable numbers. A series of 12 birds secured in Manitoba in July had fed extensively upon grasshoppers, which were then swarming in the fields. One bird had eaten as many as 91, another 86, while the average for the 12 was over 57 grasshoppers apiece, about 46 per cent of their food. Two collected in Kansas in May had fed on 86 and 80 grasshoppers, respectively, these forming 80 per cent of the food in each case. The 70 acridians eaten by a crow secured in British Columbia entirely filled the stomach except for a mere trace of an ant and a spider. Twenty-eight other stomachs of the series examined contained 20 or more of these insects. Orthopterous eggs occurred in several, but in nearly every case there was evidence that these came from the bodies of females eaten rather than from burrows in the ground.

Crows apparently have no preference as to the species of grasshoppers eaten, taking whatever comes in their path. The fragile nature of the bodies often eliminates the possibility of specific identification soon after the insects are swallowed, so the number of species recorded from stomach examination is small. Several of the most destructive forms, however, have been recognized, notably, the red-legged locust (*Melanoplus femur-rubrum*), the two-striped locust (*M. bivittatus*), the lesser migratory locust (*M. atlanis*), and the large lubber grasshopper (*Brachystola magna*).

Crows have long been recognized as persistent hunters of grasshoppers, and in late summer and fall they may be found in small squads of a family or two searching grass lands and grain stubble for these insects. The peculiar antics of the birds in attempting to capture elusive individuals have been noted by many field observers, and farmers generally have appreciated the good work the crow does at this time of year.

GRYLLIDÆ (crickets).—Crickets were found in 75 of the 1,340 stomachs, frequently associated with grasshopper remains. Most of these were the common black ground crickets of the genus *Gryllus*, and in a few stomachs they were present in considerable numbers. A crow secured in New Jersey in October had eaten 38, together with 11 grasshoppers, and another secured in Wisconsin in August had nearly filled its stomach with 20 crickets and 3 grasshoppers. Only two stomachs contained the remains of mole crickets (*Gryllotalpa borealis*), but it is highly probable that a series collected in areas where these pests are plentiful would show a larger proportion.

LOCUSTIDÆ (katydids, green or long-horned grasshoppers, stone crickets, etc.)—Katydids and allied insects occurred in comparatively few stomachs. Over much of the crow's range these are of little economic importance, but in the Northwest the crow comes in intimate contact with a notorious pest, the western cricket (*Anabrus simplex*). Six stomachs collected at Okanogan Landing, British Columbia, in June contained these insects in considerable numbers, in several cases to the extent of nine-tenths of the contents.

OTHER ORTHOPTERA.—Fragments of a few roaches (Blattidæ) and the odd egg clusters of rear-horses (Mantidæ) were the only other orthopterous remains found.

Lepidoptera (caterpillars, moths, and butterflies).

Lepidopterous remains in the food of the crow are composed almost entirely of the larvæ, caterpillars, most of which are eaten by nestling birds (see p. 60). In bulk this portion of the diet forms only 1.56 per cent of the yearly sustenance of the adult bird, compared with 5.34 per cent for the nestling. June is the month best represented, when these insects form 6.41 per cent; May is second, with 2.71; and September, third, with 2.12. Of the total number of stomachs, 1.340, lepidopterous remains were found in 297, and in a few instances formed a considerable part of the contents. A particularly noteworthy stomach was that of a crow obtained in Michigan in May. This bird had eaten 483 small caterpillars, apparently of the genus *Crambus*, to which belong the grass moths. Another collected at the same time and place had its stomach two-thirds full of caterpillars of the same kind. A bird taken in Wisconsin in September had eaten at least 50 small unidentified moths, which amounted to 90 per cent of the food; and in at least 7 other stomachs more than 10 moths or caterpillars were present. In only one instance was a butterfly identified.

Cutworms (Noctuidæ) were found more frequently than the larvæ of any other family. Among these were identified the cotton worm (*Alabama argillacea*), the army worm (*Cirphis unipuncta*), and the fall army worm (*Laphygma frugiperda*). The large larvæ of several of the silkworm moths (Saturniidæ) were detected, and in a limited number of stomachs were those of the tussock moth (*Hemerocampa leucostigma*), the spring canker worm (*Paleacrita vernata*), and eggs of the tent caterpillar (*Malacosoma americana*).

Field observers have often noted the energy with which crows hunt for caterpillars during the period when there are callow young to feed, especially in regions where an outbreak of one or another of these pests has afforded an abundant supply of nutritious food. The work of these birds on the army worm in Pennsylvania was recognized by Dr. B. H. Warren, who witnessed their activities while feeding. He reported:[1]

> The viscera of 23 crows, old and young, which were captured in different counties of the State, and in localities where army worms were abundant, were in many instances found to be gorged with the remains of these larvæ. Crows also ate the pupæ. * * * A crow would eat a handful of the worms at a single meal; and the number which a single bird would devour in a day was immense.

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[1] Pennsylvania State Col. Ann. Rpt., 1896, p. 212.

In a recent report, J. T. Zimmer of the Department of Entomology of the University of Nebraska states:

> Crows materially reduced numbers of the fall army worm (*Laphygma frugiperda*) during the fall of 1911 in southeastern Nebraska. These birds were then migrating and more common than at other seasons. This insect was quite injurious in winter wheat fields during the season mentioned in this part of the State.

In Massachusetts, where the gipsy and brown-tail moths have defoliated extensive areas of woodland and have caused great expense both to State and National Governments, crows have done good work. In this connection Charles E. Bailey, as assistant to Mr. Forbush, reports[1] that—

> a brood of crows (four young and two old birds) came * * * at 8 o'clock and stayed until almost 9. * * * They would go to a cluster of pupæ and caterpillars and eat some, but drop more than they ate. I think they took more pupæ than caterpillars * * *. The young birds took many more than the old ones. * * * I think the six crows took 200 pupæ while in sight. Some of the time they took them as fast as a hen would pick them up.

O. E. Bremner, a horticultural inspector for the State of California, in a letter to the Biological Survey, reports that—

> in the spring of 1905 a species of climbing cutworm attacked the vineyards in Sonoma County on low land along the Russian River and before we had a chance to do anything, had stripped 10 acres or more of every vestige of green, even the stems and buds, back to the old wood. When I arrived on the scene, where thousands of the worms were being destroyed by hand picking, I found large numbers of crows assembled and busily engaged in hunting out the fat worms. There has not been a repetition of the attack since and I attribute this, at least partly, to the crows.

Hemiptera (bugs, including cicadas, leaf-hoppers, stinkbugs, squash bugs, etc.).

Bugs of various kinds form less than 1 per cent (0.63) of the annual food of the crow. August is the month of greatest consumption, with 2.92 per cent, and June is next, with 1.75. Of the two orders into which these insects are divided, Homoptera and Heteroptera, the latter is better represented. This may be due to the small size of many of the homopterans and to the fact that comparatively few are strictly terrestrial. Evidence secured from the stomachs examined, however, shows that the periodical cicada (*Tibicen septendecim*) may at times enter strongly into the diet, especially of nestling birds (see p. 61). A series of stomachs of both old and young crows was collected in May, 1913, at Onaga, Kans., at a time just prior to the emergence of a brood of these insects. The birds fed upon them ravenously, most of those eaten being in the last pupal stage and probably dug out from their retreats not far below the surface of the ground.

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[1] Forbush, E. H., Useful Birds and Their Protection, p. 129, 1907.

Of the true bugs (Heteroptera), members of the stinkbug family (Pentatomidæ) are most frequently found. These strong-smelling insects occurred in a large number of stomachs, though seldom in great quantities. Inasmuch as some insects of this family are predacious, others herbivorous, and still others of varied food habits, an indiscriminate feeding on them would result in no great harm or good. *Podisus*, *Euschistus*, and *Brochymena* were the genera most frequently found. Assassin bugs (Reduviidæ) are not uncommon articles of food. Among those identified were the wheel bug (*Prionidus cristatus*), two species of *Melanolestes*, *Apiomerus crassipes*, and *Sinea* sp., all of which are predacious. Of the Lygæidæ, the notorious chinch bug (*Blissus leucopterus*) only is worthy of mention. A crow collected in Kansas in November had eaten 30 of these pests.

Diptera (flies).

Flies form a very small and, on the whole, unimportant part of the crow's food, constituting less than half of 1 per cent. Of these, craneflies (Tipulidæ) are of greatest economic interest, as their larvæ, "leather-jackets," are destructive to grass lands. The adults, pupæ, larvæ, and eggs of these insects have been taken from crows' stomachs; the eggs, however, appearing in most cases to have come from the bodies of females which the bird had eaten and partly digested. Stomachs have been opened in which the contents were blackened by many thousands of these minute ellipsoid eggs, when only a trace of the fragile parent remained to tell the story whence they came. Muscid and sarcophagid flies, their puparia and larvæ—the latter stages often associated with carrion—were present in many stomachs, and in the case of some nestlings occurred in considerable numbers. Marchflies (Bibionidæ), horseflies (Tabanidæ), robberflies (Asilidæ), and soldierflies (Stratiomyidæ) made up the bulk of the remaining food classified under this order.

Hymenoptera (ants, bees, wasps, etc.).

Of the hymenopterous insects found in crows' stomachs, ants outnumbered all other groups, but even they formed a negligible portion of the diet, as all the Hymenoptera combined formed only about two-thirds of 1 per cent of the yearly sustenance. In only one stomach were ants present in considerable numbers, and in this several hundred composed about three-fourths of the contents. Some of the larger species eaten, as *Camponotus herculeanus pennsylvanicus*, and some species of the genus *Formica*, probably are picked up by the crow whenever met, but most of the smaller forms unquestionably are eaten accidentally with carrion or dead insects over which they swarm. In either case the quantity taken is so small that the economic considerations involved are practically negligible.

Records of crows feeding on bees (Apoidea) are few and usually restricted to single insects in individual stomachs.

Wasps (Vespoidea and Sphecoidea) of various kinds are not uncommon articles of diet, and to certain beneficial species attention must be called. Digger wasps (*Tiphia*), one of the most important insect enemies of the white grub, were found in 19 of the 1,340 stomaches, a total of 24 individuals being eaten. This is indeed a limited number and is very small in comparison with the enormous number of adult May beetles (*Phyllophaga*), parents of the white grub, which the crow destroys. This may be explained by the fact that most of the *Phyllophaga* eaten are adults, the grubs, which the wasps parasitize, being taken less frequently. Of course, it is highly probable that some of the larvæ eaten had been parasitized and then their consumption by the crow resulted in the destruction of the eggs or larvæ of these beneficial insects. It can not be claimed, though, that in its feeding on white grubs the crow is doing anything but good, regardless of how many may be parasitized, as in no way are the interrelations between the wasp and the grub disturbed by this indiscriminate destruction. Of the other wasps, members of the genera *Polistes* and *Odynerus* appeared most frequently. Sawflies (Tenthredinidæ), which include the injurious currant and pear slugs, are seldom eaten by crows. Parasitic ichneumons were found in a few stomachs, though never in great quantities.

Miscellaneous insects.

Other orders of insects are poorly represented in the crow's food, together forming less than three-fourths of 1 per cent. Most of these are aquatic forms, occurring in stomachs of crows secured in marshy regions. Dragonflies (Odonata) and their nymphs, caddisflies (Trichoptera) and their larvæ inclosed in odd cases of sticks and stones, mayflies (Ephemeridæ), dobsons (*Corydalis cornutus*), and a few other neuropterous insects comprise the bulk of this food. In no case were insects of economic importance taken in large numbers.

SPIDERS.

While spiders form a large portion of the food of nestling crows (see p. 62), the adults eat but few—less than half of 1 per cent of the annual food. Most of these belong to the wolf, or running, spiders (Lycosidæ), terrestrial forms, some species of which grow to considerable size. A few jumping spiders (Attidæ), daddy longlegs (Phalangida), and a single orb-weaver (Argiopidæ) also were found. Spiders as a whole, being indiscriminately predacious, are doubtless beneficial. The wolf spiders, however, which comprise the largest portion of this part of the crow's food, are restricted in their feeding to terrestrial forms, so that many of the injurious herbivorous species and practically all flying insects, among which are many of the most noxious pests, seldom come within their reach. The exact status of these spiders, so abundant in some parts of the western prairie country, is as yet not fully understood.

CRUSTACEANS.

Stomach examination of adult crows showed that crustaceans constituted 1.17 per cent of the yearly food. By far the largest proportion of this consisted of crawfish, which were present in 150 of the 173 stomachs in which crustaceans were found. They were eaten in every month, but were taken in largest quantities in March and April, when they comprised over 3 per cent of the stomach contents. Birds collected in southern States had eaten much more of this food than their northern relatives. In fact, a series of 108 stomachs collected in the Gulf and South Atlantic States gave a percentage of 7.40, over twice the proportion recorded for the full series of 1,340 adult birds collected throughout the country. A few birds had fed almost exclusively upon these pests, while series of stomachs secured in areas where crawfish were plentiful indicated that this food was sought quite systematically, as nearly every bird had partaken of it. This work is especially noteworthy in view of the injury these crustaceans inflict upon corn and cotton in some sections of the South and the damage which is sometimes done to dikes by their tunneling.

Crustaceans other than crawfish were eaten in only small quantities. These were creatures of no special economic importance, as sowbugs (*Armadillidium* sp.), found commonly in damp cellars and under rotten logs, a few small amphipods, and, in one stomach, a sandbug (*Emerita talpoida*). A few other unidentified crustacean remains may have been of marine origin and were perhaps picked up on the beach at low tide.

MOLLUSKS AND OTHER AQUATIC INVERTEBRATES.

The crow is a persistent feeder along lake shores and river banks, where it picks up a considerable amount of aquatic food. The seashore also, with its ebbing tide exposing daily an ample supply of marine forms, is a common feeding ground of crows which roost or nest for some miles inland. The latter locality is an especially favorite one for the birds gathered along the Atlantic coast during the winter months. In these situations mollusks of many kinds frequently enter into the crow's diet. Remains of aquatic and land shells were found in stomachs throughout the year, though in bulk they compose but a small proportion of the bird's food (0.31 per cent), and in no month does the quantity exceed 1 per cent. This part of the crow's fare can be considered as only of a neutral nature.

In feeding on the larger mollusks, which it frequently secures, the crow displays an interesting method of obtaining the mussels from their hard, protecting shell. This is explained in an article on the habits of the herring gull, by George H. Mackay,[1] in which the writer claims that crows as well as the gulls possess this habit. He says:

> I cite as an instance of their ingenuity that in winter I have seen them carry up in their bills to a height of 25 to 35 feet into the air a large sea clam *Mactra solidissima* Gould), measuring 6½ inches by 4½, for the purpose of breaking the shell (that they might avail themselves of the contents for food) by dropping it on the hard beach. I have seen them carry up the same clam four times when it failed to break on account of insufficient height; but they will carry them up higher after several ineffectual attempts and thus obtain the desired results; they also carry up scallops (*Pecten concentricus*) and mussels (*Modiola modiolus*) * * *. That they usually succeed seems certain, for I have seen them eating them, and have noticed the broken shells, minus the contents, lying on the beach surrounded by their tracks. They vary this mode of proceeding in some places by carrying and dropping the clams on a cake of ice, or on a rock.

A. B. Klugh, of Queen's University, Kingston, Ontario, has written that on the coast of New Brunswick the American crow sometimes feeds on sea urchins (*Strongylocentrotus droëbachiensis*), carrying them off to the woods to eat.

FISHES.

Fish remains were found in stomachs collected in every month of the year, though in bulk they formed little over half of 1 per cent (0.56), and there is no question that most of this should be classed as carrion. As much of it was eaten in winter, however, when few carrion insects are about, little evidence was available as to the character of this food. The crow's worth as a scavenger of dead fish is mentioned under the heading "Carrion" (p. 40). Crows at times capture small fish in shallow water, but this work is never carried to an extent seriously injurious to the supply of food or game fishes. Stomach analysis shows that among those which might be so captured are shiners (*Notropis*), hornyheads (*Hybopsis*), carp (*Cyprinus*), and fallfishes (*Semotilus*).

In feeding on live fish the crow displays in a moderate degree the skill of the kingfisher. In this connection Charles Hallock has written:[2]

> Almost daily, in front of my residence on the Neuse River (Newbern, N. C.), I see the crows hovering and circling over the surface of the water looking for fish, very much after the manner of the sea gulls. They will swoop down and scoop their little prey deftly very often without breaking the surface.

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[1] Auk, IX, p. 222, July, 1892.

[2] Forest and Stream, XXXVIII, p. 320, April 7, 1892.

REPTILES AND AMPHIBIANS.

Reptiles and amphibians are frequently found in the stomachs of crows, both adult and young, though the latter take a much larger quantity (see p. 63). Such food formed 1.37 per cent of the diet of the old birds, reaching a maximum in April, when it totaled 4.38 per cent. June and July were represented with about 3 per cent each and May and August with about 2. In no other month did such food form as much as 1 per cent.

Reptiles.

Reptiles, including turtles, lizards, and snakes, were less frequently taken than amphibians. They occurred in 76 of the 1,340 stomachs. As in the case of fish remains, it is often impossible to determine whether reptilian food was picked up as carrion or acquired by the predatory activities of the crow. It is highly probable, though, that at least half the reptiles eaten were dead when found.

The turtles secured were usually young ones, some of which apparently were painted terrapins (*Chrysemys picta*) and box turtles (*Cistudo carolina*), though the disintegrated condition in which they were found prevented accurate identification. Lizards were found in 8 stomachs, but in only one could even generic identification be made. Snakes, discovered in 48 of the 76 stomachs in which reptiles occurred, formed the bulk of the reptilian food. In only two instances could more accurate identification be made, a garter snake (*Eutænia* sp.) and a blue racer (*Zamenis constrictor*) being recognized.

It is doubtful whether in its consumption of reptiles the adult crow is doing any appreciable harm or good. So many of those eaten are in the form of carrion that the remaining portion is negligible in quantity. At the same time those captured alive appear to be about equally divided between beneficial and injurious forms. Turtles are to a certain extent injurious, lizards largely beneficial, and snakes (such as the crow eats) divided between the small insectivorous and rodent-eating forms and some large species, as racers, which prey upon the eggs and young of insectivorous birds. There is no evidence that crows subsist to any extent on poisonous reptiles, even in areas where the latter are abundant.

Amphibians.

Toads, frogs, and salamanders, from their almost exclusively insectivorous habits, must be ranked among the most beneficial creatures preyed upon by the crow. The first of these especially come in contact with many of the insect pests of garden and field; frogs necessarily confine their activities to aquatic or at least moist situations, where they feed on insects less intimately connected with the economy of man, while salamanders, the least valuable of the three, are found in damp places, where occasionally a foraging crow, turning over sticks and stones, may find them. In the examination of stomachs it was found difficult in many cases, where only a small portion of the skeleton remained, to distinguish between frogs and toads, but enough identifications were made to establish the fact that frogs greatly outnumbered toads in the food of the crow. The crow's favorite habit of hunting in marshy areas probably accounts for much of this, and then, too, toads are largely nocturnal in their habits, remaining in concealment during most of the day. The fact that the latter, owing to their clumsiness, frequently meet with fatal accidents warrants the assumption that a portion of the toads eaten must be classified as carrion. Amphibians of various kinds were present in 153 of the 1,340 stomachs of adult crows, in 86 of which they were identified as frogs. In only 3 were toads recognized, though doubtless some of the remains not generally determined were of these creatures. Salamanders were detected in 29 stomachs.

WILD BIRDS AND THEIR EGGS.

The crow's antagonism to other native birds has been the basis of complaints against it from the earliest days of American ornithology, and the various changes that agriculture and the general advance of civilization have made upon the environments of many birds have had a tendency even to aggravate this evil. The establishing of game farms and preserves, where large numbers of game birds with their eggs and young are confined to comparatively small areas, has brought this obnoxious habit of the crow to the immediate notice of game wardens and game raisers. In public parks and rural districts where the crow has had protection along with other species, it has at times assumed the rôle of a most persistent nest robber, making daily visits in early morning hours among the trees and shrubs in search of nests of smaller species; and throughout our agricultural districts in general, where formerly much of the timber and brush was an effective cover for birds, the crow now has a better chance to ply this nefarious work. Complaints are made also of the crow's predatory habits in environments unaltered by the hand of man, as in nesting colonies of herons, rails, ducks, and other waterfowl. From this it would seem that the crow's bird-killing and nest-despoiling habit is not a recently acquired one, although modern conditions doubtless have aided the bird considerably.

In the search for evidence bearing on this trait of the crow stomach analysis alone does not always tell the whole story; it is important, however, especially in refuting wild and groundless accusations sometimes made against the crow by persons who have let a few personal observations, limited usually to restricted areas and peculiar conditions, suffice as evidence. Since stomach analysis falls short in identifying such readily digested food as the tender flesh of young birds, effort was made to secure from reliable observers all possible data bearing on this phase of the crow's food habits. Remains of eggs also are almost certain to escape notice when none of the shell has been eaten, and, in the opinion of some, this factor alone disqualifies stomach analysis as a method of investigation for determining the extent of such depredations. It must be borne in mind, however, that even when crows resort to "sucking" eggs, the shell is at least punctured and small fragments most likely reach the stomach. Even minute quantities of such material are readily identifiable and would seldom escape notice. Eggs up to the size of a robin's will be crushed and swallowed by the crow with almost the entire shell held together by the shell membrane, so that criticisms of this kind must be restricted to cases where larger eggs are eaten. Fragments of these have been found in a sufficient number of stomachs to indicate that crows are in no way averse to eating the shell of eggs, and, in fact, in many cases it appeared as if they took special pains to consume all they found. The writer feels confident that very few instances of egg eating by crows escape notice in stomach analysis.

The fact that the remains of young birds rapidly disappear when once in the stomach of a crow, and that it is merely the shell of an egg that can be detected and its bulk estimated, has resulted in comparatively small percentages for such items. This circumstance has led to an erroneous impression of the extent and importance of the work. Here, then, is presented a case where the percentage-by-bulk method of estimating bird food must be strengthened by other means of computing the merits of a bird's diet. It is essential that we know the frequency with which crows will resort to such activities, determined by the ratio of the number of stomachs in which wild birds and their eggs were found to the total number examined. It is also of value to know the total number of birds or clutches of eggs eaten by a definite number of crows. This latter information is of greatest importance in passing judgment on the status of nestling crows, where often the remains of a single bird or clutch of eggs is passed around to all members of a brood. To determine the exact number of individuals contained in such a series of stomachs is at best a difficult task and in many instances impossible.

Wild birds and their eggs comprised 0.32 per cent of the food of the 1,340 adult crows examined. July was the month of greatest consumption, when they formed 1.66 per cent of the food. June was second, with 0.90, and May third, with 0.70 per cent. In no other month did such food amount to as much as one-fourth of 1 per cent, August and October being wholly unrepresented. Wild birds were found in 34 of the 1,340 stomachs, an average of about 1 in every 39½, while their eggs were present in 13, or 1 in about every 103. As in no case were both birds and eggs found in the same stomach, a total of 47 out of 1,340, or 1 out of about 28½, would represent in a way the extent of the adult crow's depredations on other species. In the examination of stomachs it was found that the greatest quantity was eaten in July. This result was obtained because in three cases wild birds constituted over half the stomach contents. June, however, is the month when this food is secured most frequently. Twenty of the 203 birds secured in this month had fed on wild birds or their eggs. In May, 10 out of 197 had subsisted on similar food; and in the remaining months, when such depredations were confined to wild birds only, no eggs being taken, this kind of food was less frequent. It occurred in four of the stomachs collected in April; in three each in January, March, and July; and in one each in February, September, November, and December.

It is apparent, then, that the greatest consumption of birds by adult crows takes place during the breeding season, in May and June, and in addition there must be considered an even greater proportion of such food fed to their nestlings during the former month (see p. 64). At this time the demand for animal food of the most nutritious kind is imperative with parent crows, which may have as many as six or seven ravenous young to feed. Identification of species, whether birds or eggs, from the remains in the stomachs is seldom possible. The birds eaten are usually nestlings of smaller species, whose tender bones furnish poor material for accurate determination, and the eggshells are usually broken to small bits, from which it is difficult to judge either size or markings. A stomach of one young crow from Kansas contained one foot each of a red-headed woodpecker and an upland plover. Warblers were questionably identified in two stomachs, and single individuals of the following birds were found in others: Ruffed grouse, bobwhite, goldfinch, bluebird (?), song sparrow (?), meadowlark (?), and indigo bunting (?). The shell of the egg of a robin or wood thrush was recognized in two stomachs, that of a catbird in one, and of a meadowlark (?) in another.

While most records of attacks by crows upon other birds are associated with species of more or less confiding habits, as robins, catbirds, and brown thrashers, other species also suffer occasionally. Below is a list of birds which, according to records of the Biological Survey, have been maltreated by their black relatives. The bulk of the information was received in response to letters of inquiry sent to reliable observers:

Pigeon guillemot, herring gull, glaucous-winged gull, tern (sp.), anhinga, Baird cormorant, mallard, canvas-back, ibis (sp.), American bittern, Ward heron, little blue heron, black-crowned night heron, clapper rail, Wayne clapper rail, Virginia rail, coot, spotted sandpiper, upland plover, Wilson plover, bobwhite, ruffed grouse, prairie chicken, sharp-tailed grouse, pheasants (various introduced species), red-shouldered hawk, osprey, flicker, kingbird, least flycatcher, horned lark, blue jay, red-winged blackbird, meadowlark, Baltimore oriole, bronzed grackle, purple finch, goldfinch, vesper sparrow, English sparrow, chipping sparrow, field sparrow, song sparrow, cardinal, barn swallow, cedar waxwing, yellow warbler, mockingbird, catbird, brown thrasher, wood thrush, and robin.

Not all such misdeeds, however, should be charged against the common crow. It is apparent from the localities where some of these reports originated that the fish crow (*Corvus ossifragus*) or the northwest crow (*C. caurinus*) may have been to blame. As a matter of fact, these maritime species appear to be much greater despoilers of eggs than their inland relative, but they are frequently confused with the common crow and their misdeeds heaped upon its head.

The molesting of small song and insectivorous species by crows about dooryards involves misfortunes which come intimately to the attention of a great number of bird lovers. As the published evidence on this point is already voluminous, only a few reports are presented here.

John Lewis Childs, of Floral Park, N. Y., reports:

> It is my opinion from a close observation of crows for a period of 20 years that they do much more damage than good, not alone in the destruction of corn and poultry, but particularly in respect to the large number of smaller birds which they destroy during the breeding season. For years I have noticed that four-fifths of the nests of the robin, the wood thrush, and catbird, and many others, are robbed, either of eggs or the young birds before they are able to leave the nest. This is done almost wholly by crows, and the number of eggs and young birds of the smaller species which a pair of nesting crows will destroy during the breeding season is, in my opinion, enormous. Of course, birds like robins, which nest near houses, are not subject to this robbery so much as those which breed farther away. Yet, year after year a few crows will come sneaking about the trees and shrubbery close to my house immediately after daybreak, scanning every possible location that might contain a nest of eggs or young birds, and the number of nests that are robbed in this way right under our very nose is considerable. (1911.)

Frank M. Chapman has placed in the following forceful terms his conclusions regarding the relation between the crow and the smaller species:[1]

> While, from the nature of the case, birds' eggs and young birds can form but a small portion of the animal food supply of the crow, I believe it to be indisputable that during the nesting season they constitute a large percentage of the crow's food. Nest robbing is not occasional, but is the characteristic

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[1] Chapman, Frank M., Economic Value of Birds to the State: N. Y. Forest, Fish, and Game Commission, p. 39, 1903.

habit of the crow. Not only do they eat eggs and young birds, but they feed their offspring on them. Doubtless few crows live through May and June without preying on smaller birds, and the possibilities are that almost any one of the birds destroyed (either in the egg or out of it) is of greater economic value than the crow. The crow, therefore, in addition to the direct damage it may do to our crops, robs us of the services of birds far more desirable than itself. Even if the crow, aside from its cannibal-like propensities, was wholly beneficial, it would not, it seems to me, render us as great a service as would have been performed by the birds it destroys. In short, in my opinion the crow is one of the worst enemies of our small insectivorous and seed-eating birds, and as such is undeserving of protection."

Louis A. Fuertes, of Ithaca, N. Y., writes:

> The smaller birds, notably robins, thrushes, etc., suffer badly here, crows being very bold and coming into the yards in the suburbs and taking young robins from nests on the houses and even eating them in full sight on the lawns. Of this I have several records. (1912.)

F. H. Mosher, of Melrose, Mass., who has done considerable field work in connection with the economic value of birds in his State, asserts:

> During the past season I found two pheasants' nests and one of a grouse that had been robbed by crows. In this vicinity, where the gypsy and brown-tail moths are plentiful, the small birds have a hard time to bring through their young because of the crows. The moths denude the trees, so the crows can easily find the other birds' nests and destroy their eggs and young. (1911.)

Le Roy M. Tufts, of Farmington, Me., has written the Biological Survey as follows:

> For three weeks I arose at daylight and watched in my own and neighboring orchards, and during that time I detected crows in the act of robbing nests no less than 17 times. The next spring I trapped, poisoned, and shot about 50 of the black vandals, and these in my own and neighboring orchards, effectually preventing further depredations on the robins' nests; and, as I have followed up this plan each year, the increase of birds in this locality has been most gratifying. Whereas there were but 8 or 9 robins' nests in my orchards 10 years ago, last year I counted some 30 nests of the robin and many other birds, such as the cedar waxwing, thistle-finch, etc. (1904.)

It is a common accusation against the crow, especially among sportsmen, that it is one of the most destructive enemies of woodland and prairie nesting game birds. In a measure these complaints are probably well founded, more particularly as regards those species that habitually seek cover in which to breed, and of which they have been largely deprived by the advance of agriculture. Under such conditions the crow probably now enjoys an advantage which it did not possess formerly. In the readjustment of the relations between it and its feathered prey, which has doubtless taken place, such birds as the ruffed grouse and bobwhite are the losers.

Isaac E. Hess, of Philo, Ill., relates an instance of the destruction of a prairie chicken's nest by the crow.[1]

> * * * A few days since, a farmer told me of a crow and prairie-hen episode of which he was an eyewitness. He was plowing in a field where he had previously located a prairie-hen's nest containing 14 eggs. The nest was beside a fence between two adjoining fields, and in consequence was in little danger of being disturbed.
>
> His attention was attracted by an unusual commotion, and, drawing nearer, he saw a fight in which the hen was bravely defending her property. As he advanced to the rescue (he afterwards saw his mistake), both adversaries flew away. He found the nest sadly disturbed and four eggs punctured by the crow's sharp beak. Removing the broken shells, he returned to his work. The prairie hen, owing to its shy nature, was slow in returning, but before the farmer could plow around the field the crow (which, by the way, has never been accused of timidity) had made sad havoc of the remaining eggs.

"Crows are very destructive to eggs of wild fowl, especially ducks, partridge, sharp-tailed grouse, and prairie chicken," writes W. D. Black, of Margaret, Manitoba, and then adds, "Though prairie chicken are still very common, I have known 12 out of 15 nests to be robbed in one week. Crows are their greatest enemies * * *." (1912.)

The nests of ducks, rails, and other waterfowl also are attacked, and when crows make it a point to rear their young within easy reach of the breeding marshes of these birds, the chances are poor for the latter hatching their first laying of eggs.

Maj. Allan Brooks, addressing the Biological Survey from Okanogan Landing, British Columbia, claims that crows there—

> destroy at least three-fourths of the nests of wild ducks; only in exceptional cases are the first layings of mallards hatched. Grouse do not suffer much except the sharp-tailed. The northwest fish crow (*Corvus caurinus*), found only on the coast and coastal valleys, is a far worse pest than the western crow (*C. b. hesperis*). The latter does some service in destroying grasshoppers, the former lives mostly on animal matter * * *. (1911.)

C. Wm. Beebe, of the New York Zoological Park, reports:

> In the New York Zoological Park a few individual crows before, during, and after the nesting season acquire the habit of feeding on the eggs and young of the mallards which breed here. Altogether we have lost about 400 or 500 ducklings and many score of eggs. The former are often snatched from the water as they are swimming. When the particular marauders are killed the other crows in the park do not cause any trouble. (1911.)

Heron rookeries, especially those of the black-crowned night heron, are favorite resorts for marauding crows. These herons appear to be utterly helpless before the attacks of their more wily and aggressive enemies, and the total destruction of at least one laying of eggs is inevitable where nesting crows are at all abundant.

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[1] Oologist, XVII, No. 9, p. 136, Nov., 1900.

From North Dakota, Alfred Eastgate, warden of the Stump Lake National Bird Reservation, writes:

> Last summer I saw a colony of between 300 and 400 nests of the black-crowned night heron entirely cleaned out by the crows. Ten per cent of the eggs of all the birds are taken by the crows that nest about the shores of Stump Lake. I have seen 29 nests of canvas-backs in one marsh eaten by them in one day. (1912.)

Robert P. Sharples, of West Chester, Pa., finds a mitigating circumstance in the raiding of early layings of heron eggs which would indicate that the depredations of crows may not always result in dire consequences. In a letter to Dr. B. H. Warren he says:

> I do not object to crows raiding the early heronries. I believe that nature has made a mistake in teaching these birds to nest so soon. The first eggs are always laid so that when the young hatch they are liable to destruction from storms. Then the old birds will not raise a second brood. But if the first-laid eggs are destroyed soon after deposition, then a second laying comes near a month later, and the birds have a far better chance of arriving at maturity. (1914.)

Numerous other reports of serious inroads upon herons and marsh-nesting birds have been received from the South Atlantic coastal plain, but as the observers of such occurrences seldom fail to differentiate between the two species of crows inhabiting this area, these citations are omitted.

From undeniable evidence furnished by stomach analysis, together with corroborative notes obtained from a multitude of reliable observers, it must be concluded that the destruction of other native birds and their eggs by the crow is a noxious trait of no small importance. Though all these species had been able to withstand this natural drain upon their numbers while under primitive environment, the many added taxes laid upon them by modern conditions, due to various agricultural activities, the draining of marshlands, the cutting of timber tracts wherein they had formerly nested, and the reduction of their numbers by hunting, have placed these birds in a disadvantageous position to resist the attack of their corvine neighbors.

The one circumstance which mitigates this evil is the fact that most of the depredations upon eggs and very young birds are committed during the breeding season of the crow, which is early enough to permit practically all the birds suffering losses to raise a second brood at a time when they need fear little from crows. This, no doubt, is just what takes place in many suburban districts and in breeding grounds of waterfowl, where every year crows secure much food for their young, yet the species preyed upon are seldom exterminated. There can be no question, though, that in public parks, in the vicinity of game farms, on game preserves, or other areas where it is desirable to foster certain species in numbers abnormal to the allotment decreed by nature the crow must be held in check, and in some sections a substantial reduction in its numbers is a prerequisite to success in such enterprises. Grouse and quail are able to hold their own if given sufficient cover.

POULTRY AND THEIR EGGS.

Next to the pulling of sprouting corn, the destruction of poultry and their eggs is the phase of the crow's life habits that is brought closest to the attention of farmers generally. Though many extensive raisers of poultry have had little or no complaint to enter against the crow on this score, the frequency of occurrence and severity of damage on other farms indicate that the capabilities of the crow in this direction are too important to be overlooked. Judging from replies to letters of inquiry, there appear to be two areas in which this trait is developed to a higher degree than in others. In New York and Pennsylvania in the East and in Illinois and Indiana in the Middle West crows seem to be somewhat more addicted to the habit of destroying poultry and eggs than in surrounding districts. Ofttimes reports of striking similarity have come from localities widely separated, while circumstances diametrically opposite have occurred on neighboring farms. This fact, established by evidence from numerous able observers, indicates that the destruction of domestic fowls is a loss governed largely by local conditions, as the proximity of crows' nests, the presence of young crows, and the accessibility of poultry and their eggs. That this obnoxious trait is developed to an unusual degree in certain individual crows is also apparent. It was, in fact, the opinion of 121 observers out of 174 who expressed themselves on the subject that the poultry-molesting habit is one mainly of individuals, and that killing the comparatively few guilty of such misdeeds would practically prevent further similar trouble.

As in the consumption of wild birds and their eggs, domestic fowls, their young, and their eggs were shown by stomach analysis to constitute but a small portion of the bulk of the food—only 0.57 per cent. Such food was most important to the crow in May and June, when 1.49 and 1.33 per cent, respectively, was consumed. The next greatest proportion, 1.26 per cent, was eaten in November. In no other month did such food total as much as 1 per cent, and in August and October it was altogether lacking. Remains of chickens were present in 29 of the 1,340 stomachs, an average of 1 in about every 46. Eggs were eaten more frequently, being found in 35, an average of 1 in about every 38. Since in one stomach both a chicken and an egg were found, the frequency of depredations of adult crows on the barnyard, as determined by these stomachs, may be represented by the ratio of 63 out of 1,340, or about 1 in every 21, a lower ratio than is recorded for such food in the stomachs of nestling crows (see page 65). In a few instances accurate determination could not be made, the remains being indistinguishable from those of wild birds. Most of the depredations on poultry are committed during the crow's breeding season, May and June. Over half the records of such feeding were secured from material collected in these two months, 21 in May and 11 in June. From the fact that 12 of the 127 stomachs collected in January contained poultry or their eggs, it would seem that a portion, at least, of such food should be classed as carrion.

The mentioning of a few occurrences of trouble experienced by poultry raisers will indicate the gravity of the issue and show the extent to which crows may conduct their operations under favorable conditions. Dr. Leon J. Cole gives, in his report[1] of investigations regarding depredations of the crow, the following two cases:

> The first of these was reported by Dr. V. L. Leighton, who has an extensive poultry plant not more than a half mile from the Experiment Station in Kingston. * * * He was troubled most seriously from about April 1 to July 10. This is just the season during which the crows are raising their young and the young are learning to forage for themselves. Dr. Leighton estimates that during this period he lost, from the depredations of the crows alone, in the neighborhood of 100 chickens, which was about 25 per cent of those hatched and not lost from other causes. All sizes were taken, from the time they were just hatched until they were a pound in weight. The larger chicks the crows killed and ate where they caught them, but the smaller ones they carried away in their beaks. Various efforts were made to keep the crows away, most of which were ineffectual. * * *
>
> The other instances * * * occurred near Cumberland Hill, in the northern part of the State. This was on the farm of Mr. E. E. Church, who was attempting to raise ducks on a suitable pond not a great distance from his house. The first lot hatched consisted of 135 ducklings; later in the season there remained of these but 14. In a later lot he had 70 ducklings and saved only 13 of them. The loss of nearly 87 per cent he attributes almost wholly to crows.

In a report similar to numerous others reaching the Biological Survey, G. S. Baker, of Rehoboth, Mass., states:

> Last spring I lost about 40 Rhode Island red chickens in 3 or 4 days. When the loss was discovered, a watch was kept and a crow was seen to come from a pine grove, take a chicken, and come back in 10 to 15 minutes for another. This crow was promptly shot and no more chickens were taken. (1912.)

Dr. Raymond Pearl, biologist at the Maine Agricultural Experiment Station, at Orono, explains that even less drastic methods have protected the poultry at the station:

> Crows are by far the most destructive enemies of poultry in the vicinity. They kill chickens up to and exceeding their own size. This past season we

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[1] Cole, Leon J., The Crow as a Menace to Poultry Raising: Rhode Island Agr. Exp. Sta., 21st Ann. Rept., 1908, pp. 314–315.

were obliged to string the top of our poultry range with binder twine (strands 2 feet apart), the strands being stretched from division fence to division fence. In no other way were we able to stop the crows killing chickens. (1912.)

As the majority of reports give evidence that the poultry-stealing habit is one of individuals, it appears that combative and protective measures may be employed with success. The shooting of the particular marauders has in most cases put a stop to the trouble. Where losses to young poultry and eggs were at all severe, the use of wire netting to cover yards containing chicks and the provision of proper houses for nests have been effective, and the investment has soon paid for itself by the absolute protection afforded. The destruction of a near-by nest frequently prevents further loss to poultry, and crows may be retained throughout the general area to render good service to the farmer.

For additional control measures see pages 73–80.

SMALL MAMMALS.

In the destruction of injurious mammals the crow does work seldom recognized by the average farmer. While individually it may not be so aggressive in its pursuit of a victim as some of the birds of prey, the crow makes up such deficiencies by its greater numbers. The persistence of a squad of the black fellows mobbing a frightened cottontail rabbit or patiently searching grass hummocks for nests of mice early in spring is distinctly corvine. Stomach analysis gives ample proof of this trait, and, while specific identifications can not be made in most cases, the fact that mammals have been eaten is readily proved. Difficulties arise, however, in the distinction between mammal remains eaten as carrion and those secured alive. In identifying carrion among the remains of small mammals the writer relied entirely on the character of the associated insect remains. Necrophagous insects, as Silphidæ among beetles and the larvæ and puparia of blow flies, most frequently supplied this evidence.

Mammals comprised 1.64 per cent of the yearly food of the adult crows examined and were eaten in every month. The greatest consumption was in April, when such food totaled 4.10 per cent of the diet. In May 3.24 per cent was recorded; in March, 2.77; and in July, 2.60. In all other months the percentage was less than 2, being practically nothing (0.05 per cent) in September. Mammals occurred in 134 of the 1,340 stomachs, an average of 1 in every 10. Of these remains, injurious rodents formed the major portion. These pests were identified in 82 of the 134 stomachs in which mammals were present and doubtless occurred in many others where accurate determination could not be made. In bulk they formed approximately three-fourths of the mammal food, a yearly percentage of 1.22 being recorded. March to July, inclusive, is the time of year when the greater part of this food is eaten, the maximum quantity (2.65 per cent) being taken in May.

Cottontail rabbits (*Sylvilagus* spp.), especially the young, were the rodents most frequently taken by adult crows, being found in 21 stomachs. It is doubtful whether crows during the breeding season play a less important part in the control of these animals than do any of the birds of prey. In areas where cottontails are plentiful they form an important part of the food of nestling crows (see page 66) and, quite naturally, the parent birds subsist on much the same fare. This food habit appears to be universal, records coming from all parts of the country. In four instances cottontails formed over half the stomach contents.

The following account of an attack by a crow upon a cottontail is given by Prof. W. B. Barrows:[1]

> On one occasion the writer saw a tragedy of this kind while driving along a Maryland road in June. A crow suddenly sailed over the fence and alighted in the road about 100 yards ahead of the horse. As he lit, he struck savagely with his bill at some dark object on the ground which tried to escape by jumping from side to side, but the crow followed each motion, striking quickly and heavily each time until the animal lay quiet, when, after a thorough pounding, the bird prepared to tear his quarry to pieces. Alarmed by the near approach of the wagon, he seized his prey in his bill and flew heavily over the bushes which fringed the road. Creeping to the fence I was able to identify the victim as a young rabbit, and subsequently found its tracks in the road at the point where the crow had attacked it. My companion said that usually he had seen young rabbits at this place in the road for a week past, but this was the first time he had seen one attacked by a crow.

Of the smaller rodents, meadow mice (*Microtus*) are the favorite food of the crow. They were identified in 20 of the 1,340 stomachs, in some of which they constituted a substantial portion of the diet. In one stomach, collected in New York in March, a meadow mouse made up 87 per cent of the contents; in another from the same State two individuals composed 38 per cent of the food; and in 5 others such rodents formed over three-fifths of the diet. Remains of white-footed mice (*Peromyscus*) were present in 5 stomachs, in one of which they amounted to 60 per cent of the contents. House mice (*Mus musculus*) were eaten by 5 crows. A brown rat (*Rattus norvegicus*) was captured by one. Four of five crows collected in Louisiana in January had fed on apparently more than one cotton rat (*Sigmodon hispidus*). The birds were secured at the same time and place and all probably were engaged in the same hunt. A harvest mouse (*Reithrodontomys*) and a pocket gopher (*Thomomys*) also were found in separate stomachs.

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[1] Barrows, W. B., The Common Crow of the United States: U. S. Dept. Agr., Div. Ornithol. and Mamm., Bull. No. 6, pp. 31–32, 1895.

A few other mammals were identified, but they form a negligible portion of the adult crow's food. One bird collected in Wisconsin in May had eaten a short-tailed shrew (*Blarina brevicauda*) which practically filled the stomach. Two others secured in Maryland also had fed on shrews. Moles (*Scalopus*) were found in two stomachs, and a weasel (*Putorius*) and bat in one each. A tooth of a house cat was discovered in one stomach but was classed as carrion.

It is evident that the crow's destruction of mammals must be construed as a distinctly beneficial trait. Its greatest activities along this line are directed against rodents, in the control of which it well supplements the good work of hawks and owls, which unfortunately are now much too scarce in some sections.

ANNOYANCE TO LIVE STOCK.

The crow is accused of molesting and in some instances actually killing live stock, as young lambs and swine, and no doubt in some cases he is guilty. On this habit stomach examination sheds no light, but in view of complaints that have reached the Biological Survey it can not pass without comment, although these complaints are isolated and few in number and doubtless comparatively little aggregate loss has been suffered.

Mrs. Emma E. Drew, of Burlington, Vt., writing under date of January 4, 1912, says that in the country where sheep and lambs are out in the fields, crows sometimes swoop down on to young lambs and peck out their eyes; and that farmers in Au Sable Forks and Jay, N. Y., complained bitterly of the crows in this respect.

W. L. McAtee, of the Biological Survey, has informed the writer that, on G. G. Hammond's farm, Squibnocket, Martha's Vineyard, crows developed a habit of killing young merino lambs by pecking into the brains, which, with the eyes, were eaten. More than 50 lambs were killed in 1908. A bounty of 50 cents apiece was then offered and resulted in the destruction of about 40 birds. There has been no trouble since, and the normal number of lambs was reared the following year.

CARRION.

It is often difficult to determine the origin of such animal matter as flesh and bone fragments found in stomachs of crows. This may have been carrion or it may have been torn from the body of an animal killed by the bird itself. It frequently happens, however, that the stomach also contains insect remains, as carrion beetles (Silphidæ), short-winged scavenger beetles (Staphylinidæ), tumblebugs (*Canthon*), or scavenger flies and their larvæ and puparia, which furnish strong circumstantial evidence of the character of the fleshy food eaten. In examining the stomachs every possible effort was made to determine the nature of this animal food. Error may have crept in in some instances, but a sufficient number of accurate identifications of carrion were made to warrant the assertion that crows readily consume such food at any time of the year and, when winter deprives them of much of their customary food, they will subsist extensively upon it.

The stomachs of adult crows examined revealed a yearly percentage of carrion of 2.58. This consisted of remains of small mammals, some chickens, fish, pieces of flesh and bone torn from larger carcasses, horse hair, hog bristles, and the like. It is highly probable that a large portion of the fish remains mentioned on page 27 also should be classed as carrion. January was the month of greatest consumption when such matter constituted nearly 9 per cent of the food. The other months were varyingly represented: April with 5.24, February, March, May, and September with from 2 to 3, and the remaining months with less percentages, down to July, which had only 0.29. In general these figures showed a greater consumption of carrion during the colder months.

Field observations indicate the extent to which these birds will sometimes subsist on offal, and numerous instances are on record of their rendering valuable service as scavengers. Dr. S. D. Judd, in writing of his experience with these birds in Maryland, said:[1]

> Crows and buzzards are valuable scavengers of dead fish cast up at low tide during the last of April and the first of May, when the fishing season is at its height. These fish are small, principally sunfish, white perch, and shad that were fatally injured by nets. Observations on May 5, 1901, showed the whole river front of the farm strewn with decaying fish, which gave out such a stench that one could not sit comfortably within several hundred yards of the beach. Some 40 buzzards were feeding on the carrion all day. On close inspection they were seen to be selecting that which was most badly decomposed. Crows in almost as large numbers and several crow blackbirds were also feeding, but they commonly took that which was less decayed. Several crows came repeatedly to the shore of lot 1, picked up fish, and carried them to their nests in the woods. By abating this nuisance crows and buzzards do a service that is appreciated by the occupants of the farmhouse.

P. S. Farnham, of Owego, N. Y., has written to the Biological Survey, stating—

> From pollution or other cause a great many fish die during the summer in the Susquehanna River here. The crow keeps these dead fish fairly well picked up. During a rise in the river this last summer I sat upon the banks near Campville and watched the crows. The dead fish were floating down and as soon as a crow saw one he would fly out, pick up the fish, take it ashore, and eat it. (1911.)

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[1] Judd, S. D., Birds of a Maryland Farm: Bull. 17, Biological Survey, U. S. Dept. Agr., p. 53, 1902.

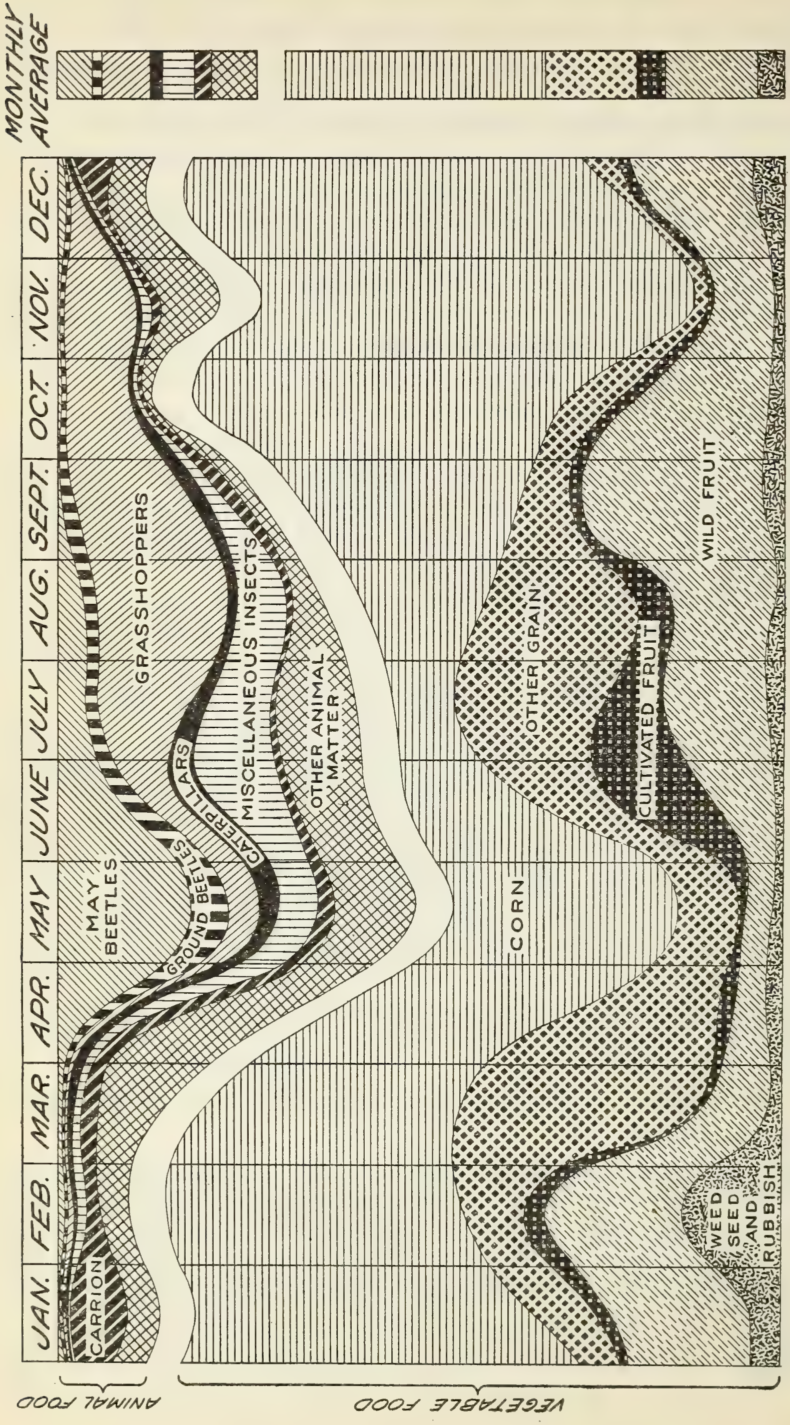

FIG. 2.—Food of adult crows. Showing the varying quantities of the principal items from month to month, and the relative monthly average of each item. In Table II, page 43, is presented the same information in percentages.

Regarding the winter feeding habits of these birds in the vicinity of Geneva, N. Y., Prof. E. H. Eaton, of Hobart College, reports that in the winter of 1911–12 there were hundreds of dead ducks on the ice of Seneca Lake, which was frozen for the fourth time in its history. These attracted considerable flights of crows. The crows fed also on the garbage which was carried from the city of Geneva in various directions to the north and northeast, and they followed the line of the Seneca River, evidently attracted by dead fish, crawfish, frogs, and other creatures which they were able to pick up along the margin.

Slaughter houses, fish and lobster canneries, and the mouths of sewers are favorite rendezvous of crows. Here these birds are assured an ample supply of food even in severe weather. Under such conditions their presence is highly desirable.

VEGETABLE FOOD.

Examination of stomachs has shown that the crow is largely a vegetarian. Vegetable food formed 71.86 per cent of the annual diet of the adult crows available for this investigation. In only one month, May, did it constitute less than half the total, in which case 47.56 per cent was recorded. In the months following, a uniform increase was noted. June was represented by 53.02 per cent; July by 55.72; August, 60.60; September, 67.68; and October, 85.71. In November a decrease occurred (81.26), but in the winter months, December, January, and February, very large quantities again were eaten, represented by the percentages of 86.82, 85.06, and 89.03, respectively, the last being the largest quantity recorded for any month. The vegetable portion decreased rapidly in March (83.95) and April (65.91). Figure 2, on page 42, represents diagrammatically the variations in the vegetable as well as the animal food eaten in the different months.

TABLE II.—*Monthly percentages of the principal food items of the adult crow.*

Kind of food.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average
May beetles, etc	0.18	1.19	1.04	4.98	20.79	10.06	4.47	5.26	0.91	0.54	0.77	1.17	4.28
Ground beetles	.07	.10	.26	2.30	5.54	3.24	2.13	1.76	2.31	.14	.74	.19	1.56
Grasshoppers	.51	1.14	.56	1.84	4.29	5.83	14.04	19.14	19.24	8.68	10.73	2.07	7.34
Caterpillars	.18	.41	1.36	1.13	2.71	6.41	1.95	.62	2.12	1.19	.30	.39	1.56
Miscellaneous insects	.35	2.01	1.36	4.47	6.44	10.41	11.26	8.29	3.06	.96	1.62	.67	4.23
Carrion	8.95	2.45	2.66	5.24	2.13	1.48	.29	.95	2.69	.32	1.44	2.37	2.58
Other miscellaneous animal matter	4.70	3.67	8.81	14.13	10.56	9.55	10.14	3.38	1.99	2.46	3.14	6.32	6.57
Corn	51.95	43.19	36.85	35.28	33.26	20.53	9.13	17.96	29.60	54.33	63.93	65.00	38.42
Other grain	7.00	9.74	34.22	20.90	8.43	10.20	20.22	22.80	8.33	7.08	2.67	.89	12.70
Cultivated fruit	2.55	3.42	.26	2.74	.91	14.12	9.31	5.79	1.66	2.40	.07	1.36	3.74
Wild fruit	19.76	19.57	10.65	5.06	3.49	7.28	14.05	13.67	25.82	20.50	12.94	14.75	13.96
Weed seeds and rubbish	3.80	13.11	1.97	1.93	1.45	.89	3.01	.38	2.27	1.40	1.65	4.82	3.06

CORN.

Complaints most frequently heard against the crow concern its depredations on corn. Injury to this crop may be either to the sprouting grain, to the grain when in "the milk," or "roasting-ear," stage, or when the ripened corn has been stacked in shocks. Of the three, the last form of injury appears to be the least serious. The pulling of sprouting corn, fortunately, may be largely prevented by the use of deterrents (see p. 74), but the damage to the grain when in the "roasting-ear" stage constitutes the most vexatious form of damage of which the crow is guilty. This results not so much from the grain the crow actually eats, as from the subsequent injury caused by water entering the ears from which the husks have been partially torn.

Stomach analysis has shown that corn is without question the staple article of diet of the adult crow, and even the older nestlings are fed a considerable quantity (see p. 67). This grain constituted 38.42 per cent of the yearly food of the 1,340 adult crows examined. In July, the month in which practically no growing corn is available, the monthly percentage recorded reached its lowest point, 9.13. Late in August corn in the "roasting-ear" stage becomes accessible over much of the area in which crows' stomachs were collected, a fact shown by its increased proportion in the food, 17.96 per cent. September is represented by an even greater quantity, 29.60 per cent, much of which was doubtless pilfered from the ripening crop. In October corn exceeds all other foods combined (54.33 per cent), but the harvest, with its attendant waste of grain, may account for a portion. Late November and all of December, January, and February are times of dire privation for the crow and the fact that it can find in these four months subsistence mainly from waste corn, sufficient to supply 63.93, 65.00, 51.95, and 43.19 per cent, respectively, of its food, speaks well for the persistence and frugality of the bird. In March and April less quantities are taken (36.85 and 35.28 per cent, respectively), and these also may be relegated largely to the category of waste grain. Some of the corn eaten in April may have been from the sprouting crop, especially in the case of crows collected in the Southern States. Had a greater series of stomachs been collected in the South, more consideration would have to be given to the earlier planting and sprouting time in that region. In May, however, when corn formed a substantial portion of the diet (33.26 per cent), a considerable part was doubtless secured from newly planted fields. But when it is considered that in June corn still formed over a fifth (20.53 per cent) of the food, at a time when comparatively little can be obtained in this way and when even less waste grain is available than in the preceding month, it is apparent that even in sprouting time at least half the corn eaten by the crow probably represents no loss to the farmer.

An idea of the corn-eating proclivities of the crow at various times of the year may be gained also by noting the frequency with which such food was eaten, as presented in Table III.

TABLE III.—*Relation of the number of stomachs containing corn to the total number examined.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Total number of stomachs	127	69	132	89	197	203	100	42	75	177	57	72	1.340
Number of stomachs containing corn	97	43	86	73	112	90	21	15	39	137	49	62	824
Percentage containing corn	76.37	69.35	65.15	82.00	59.89	44.33.	21.00	35.23	52.00	77.40	85.96	86.11	61.49

It will be seen by comparison with Table II (p. 43) that, with the exception of April, the story of the corn-eating habits of the crow, as determined by the frequency of feeding, is almost identical with that revealed by the bulk of corn taken. July is the month represented by the lowest percentage. The ratio then increases uniformly until the last of December, after which a regular decrease is noted, except for April, as previously cited, when an unusually large proportion of the birds had fed on corn in small quantities.

Individual stomachs in which very high percentages of corn were recorded were found frequently in the material examined. Fifty of the 1,340 stomachs of adults were filled with this grain exclusively, 97 contained from 95 to 99 per cent, and 59 contained over 90 per cent. Most of these large percentages were recorded in October, when 56 of 177 crows had subsisted on corn to the extent of more than 90 per cent of their food.

Tabulation of the results of stomach analysis under the separate States in which the material was collected revealed little of special interest. The frequency of the corn-eating habit could be satisfactorily determined in only a few States because of insufficient material. Of the 198 adult crows collected in Maryland 147 had fed on corn; from New Jersey, 134 out of 161 had eaten such food; and from New York, 41 out of 122. An example of the unsatisfactory results obtained from a few stomachs collected at the same time and in identically the same environment is shown by a series of 48 crows collected in North Carolina in January. Forty-five of these had fed on corn, which comprised nearly 65 per cent of the food. As this constituted all the material from this State, it would be manifestly wrong to let this evidence stand as the sole basis for determining the relation of the crow to the corn crop in North Carolina.

A perusal of many replies to inquiries sent to various parts of the country in 1911 and 1912 shows some diversity of opinion even in restricted localities, but by a tabulation of the data under the various States a very good idea of opinions in the different parts of the country has been obtained.

By far the severest criticism of the corn-eating proclivities of the crow comes from the Northeastern States, including Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia. These States, according to the statistics of 1912, devoted about one twenty-fifth of their total area to the cultivation of corn. On the other hand, comparatively little complaint was heard from the farmers of the upper Mississippi Valley, in the States of Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa, Missouri, Nebraska, and Kansas. Of these States Ohio, Indiana, and Wisconsin appear to have the greatest grievance against the crow, though even here, with the possible exception of Indiana, the consensus of opinion was that damage was not serious. In this part of the upper Mississippi River valley nearly one-sixth of the total area (or four times the ratio for the Northeastern States) was devoted to corn.

Along with these seemingly irreconcilable figures comes the fact that, notwithstanding the drains which the crow is supposed to make on the corn crop, the farmer of the Northeast produced nearly as many bushels to the acre as his western competitor. As the crow is practically as numerous over much of this western area during spring and summer as in the Eastern States, one is compelled to look further for the cause of its being so much more unwelcome to the corn raisers of the East. A comparison of conditions prevalent about the average cornfield of the East and the West may suggest the solution. The very fact that the ratio of the corn acreage to the total area of the West is approximately four times that of the East indicates the existence of much larger fields. The comparative scarcity of timber suitable for nesting sites in some sections of this western country confines the crows during sprouting time to the vicinity of the limited wooded areas, leaving extensive corn lands wholly free from their attack, while in the East the smaller fields with the intervening wood lots produce conditions admirably adapted to the needs of these birds. Then, too, the existence of more intensive farm operations on the smaller fields of the East accounts in large measure for the increased yield per acre, and at the same time gives reasons for the unfavorable opinion regarding this bird. Losses, though even slight, are likely to attract the attention of the assiduous cultivator of a small crop, while damage, oftentimes extensive, frequently will be overlooked by the owner of large fields, especially when the actual cause of the injury has escaped notice.

Dr. S. D. Judd, relating his personal experience with corn-pulling crows, has said:[1]

> The crow is by all odds the worst pilferer of the cornfield. * * * In 1899 the replanting was more extensive than usual, requiring on the 39-acre field 1 bushel 2½ pecks, 46 per cent of the 3½ bushels originally planted. This unusual ratio was probably caused by the failure of the cherry crop.

L. E. Wilcox, of Butterfield, Ark., complains that—

> in this immediate neighborhood we have been overrun with crows. They have destroyed fully 10 per cent of the corn crop by picking into the ears during the roasting-ear stage, eating some ears nearly up; and rains afterwards rotted the rest of the ear. (1912.)

From New Jersey comes this account submitted by Justus von Lengerke:

> The damage done by crows to the little mountain farmer by pulling seed and sprouting corn is considerable, and total crops have been ruined thereby, while others are badly damaged, necessitating a partial replanting, when the corn will mature at different periods. They also do some damage to corn when in the shock. (1911.)

E. P. Robinson, of Packer, Conn., states that the crow does great damage by pulling corn when it first appears above ground and until it is 10 inches high, and again in August and September before cutting. He also says that it damages corn fully $5 an acre in eastern Connecticut each year, and that some fields are wholly destroyed.

Drawing conclusions, then, from both stomach analysis and field observations, it is evident that the crow is accountable for considerable direct damage to the corn crop. While careful interpretation of the results of laboratory investigation reveals the fact that this grain, taken when sprouting, when in the "roasting-ear" stage, or before harvest, forms a relatively small portion of the crow's annual supply of corn, such circumstances can not mitigate the evil done. Much may be done, however, by treating the seed grain with deterrents to make the sprouting crop largely immune to attack; frightening devices help some while the grain is ripening (see p. 74); and prompt harvesting and proper housing of the grain will prevent much of the loss at present suffered, especially in some of the Southern States where corn in shocks frequently is left standing all winter, tempting provender for roving bands of underfed crows.

OTHER GRAIN.

Grain other than corn formed 12.70 per cent of the food of adult crows. Wheat, oats, and buckwheat constituted practically all of this, the first being most often eaten. Tabulation of the monthly percentages of these grains reveals two periods of great consumption. The high tide of one is reached in March, when they formed over a third (34.22 per cent) of the diet. From this point a decrease through April (20.90 per cent) to May (8.43 per cent) was noted, after which the monthly averages again increase. In June small grains formed 10.20 per cent of the food; in July, 20.22; and in August, 22.80, the second period of great consumption. A marked decrease occurs in September (8.33 per cent); October is represented by 7.08; November, 2.67; and December, 0.89, the minimum monthly quantity recorded. In January and February these grains formed 7.00 and 9.74 per cent, respectively, of the food. Inasmuch as wheat predominated among the smaller grains, it is possible that the two maximum periods (March–April and July–August) are indicative of the sowing and sprouting season in spring, and of the harvest of the crop late in summer.

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[1] Judd, S. D., Birds of a Maryland Farm: Bull. 17, Biological Survey, U. S. Dept. Agr., p. 65, 1902.

Wheat.

Wheat was present in 227 of the 1,340 stomachs of adult crows, an average of about 1 in every 6. Local influences, especially the absence of corn, appear to determine the extent of the crow's depredations on this crop. Stomachs collected in the Northwest illustrate this point. Four crows collected at Corvallis, Oreg., in January, had fed on wheat exclusively, over 237 kernels being counted in their stomachs. Three of five stomachs secured in Saskatchewan in April were practically filled with this grain. All of a series of 10 crows from Manitoba, also taken in April, had fed on wheat, which comprised over two-thirds (68.9 per cent) of their food. In the stomachs of six others, secured in Manitoba in the month following, it formed over 40 per cent of the contents.

When attacks upon wheat are made in sowing or sprouting time, the depredations of even a single crow, limited only by a most ample gizzard, may be of considerable consequence. Two birds collected in Manitoba in April had eaten 140 and 133 kernels, respectively. Another taken in the same place in May had devoured 86, while one collected in British Columbia, in March, had made away with 54 kernels of wheat and 7 of oats. At harvest time and after, a large part of the wheat eaten by crows may well be classed as waste, involving no loss to the farmer. Birds collected in wheat-raising areas at this time of year usually were well fed. Six stomachs contained 135, 120, 91, 90, 65, and 60 kernels respectively, and in several others over 25 kernels were noted.

Evidence of the wheat-eating habits of the crow revealed by stomach analysis has been corroborated by field observation. Dr.

H. A. Surface, former State Economic Zoologist of Pennsylvania, reported the following:

> I note for example that crows have done a great deal of damage on adjoining wheat fields during the winter time by eating almost every leaf of the wheat that was above the ground or snow. One wheat field on our place, which should be quite green, is now about bare. (1912.)

Henry W. Marsden, of San Diego, Cal., complains of the destruction of wheat when in the shock (1912). Edwin Loreman, of Morrison, Ill., reports damage to both wheat and oats, which are scratched out at sprouting time (1912); and H. Martyn Micklem, of Shipman, Va., writes that "crows eat quantities of seed wheat and seed oats when the grain is imperfectly covered. Most writers appear to overlook this."

Oats.

Oats occurred in 114 of the 1,340 stomachs of adult crows, an average of about 1 in every 12, or half the number in which wheat was found. When it is considered that oats are readily available at all times of year in horse droppings, from which also the birds may secure coprophagous insects, the quantity of this grain in their diet need not greatly concern the farmer. Only occasional reports of crows attacking the sprouting crop have come to hand. The habit must be considered one of the minor offenses of the crow, from which individual farmers here and there suffer.

Other small grains.

Buckwheat was found in 107 stomachs, but if a larger proportion of the birds had been collected in areas where this grain is extensively grown, it probably would have been found in a far greater number of stomachs. The seeds of Polygonaceæ are a favorite food of birds generally, so it would not be surprising to find that the large meaty kernels of buckwheat are an even greater attraction to crows than stomach analysis seems to indicate. That buckwheat is eagerly eaten was noted especially in a series of 45 crows collected in New Jersey in March; this was prior to the sowing time, so that the buckwheat eaten must have been either waste from the preceding year's crop or from volunteer plants along roadsides. Thirty-eight of these birds had eaten buckwheat, which formed 66 per cent of their food, and 11 of them had subsisted exclusively upon it. Another series of 100 birds collected at the same place during October revealed but little consumption of buckwheat. This grain, eaten by only 23 of these birds, constituted 6.15 per cent of their diet. The only report of damage to this crop is from D. W. Southard, who complains that crows inflict considerable injury to buckwheat in the vicinity of Gilboa, N. Y.

Injury to kafir corn (sorghum) in autumn has been reported from Kansas and Oklahoma. These depredations usually have been in the vicinity of roosts, where, during the roosting period, many thousands of crows are congregated and day after day feed over a comparatively small area. Stomach analysis sheds little light on this habit, as only 5 stomachs contained the grain, but an idea of the severity of the attacks may be gained from the following communication from George W. Seigel, of Chetopa, Kans.:

> As to kafir corn, which is to become a staple crop here, they [crows] simply eat all the grain. The kafir fodder, which is a fine stover feed, is of such a juicy nature that it will not stand stacking. When the crows were taking ours so persistently in the shock we hauled it in and stacked it in the barn. This molded so badly that the fodder was not fit to use and what was stacked outdoors rotted.

F. F. Crevecoeur, of Onaga, Kans., reports that crows damaged about 50 bushels of kafir corn on one farm near a crow roost.

Rye was found in six stomachs.

MISCELLANEOUS CROPS.

The crow is guilty of damage to many crops which, from the nature of their vegetable composition, can not be detected or accurately separated from other items of the stomach contents. Among these may be mentioned numerous fleshy fruits, as apples, pears, and prunes; the rind and pulp of melons; the meat of nuts which have been partly digested and fail to have fragments of the shell associated; and the fragmentary remains of some tubers. Though many of these have been satisfactorily identified in stomachs, the presence of small quantities intimately mixed with other material is probably many times overlooked. Here again conclusions must be based to a certain extent on the evidence furnished by field observers.

Though 186 of the 1,340 adult crows had fed on what appeared to be cultivated fruit, 47 of these records were made from the 1st of November to the end of May, when the fruit eaten must necessarily have been waste. Frozen apples or inferior pumpkins left in the fields after harvest are highly prized by foraging crows late in winter and apparently are sources from which some of the birds examined had secured food. The seeds of certain cultivated fruits, as blackberries, mulberries, grapes, and strawberries, are so similar in appearance to wild varieties growing in the same areas and ripening at the same time, that it was impossible satisfactorily to classify many of them. It is highly probable that many of the fruits supposed to have been pilfered from the farmer's crop really were secured from nature's ample supply. Evidence furnished by stomach analysis indicates that grapes, strawberries, blackberries, raspberries, and apples are the fruits most often eaten. But probably next in importance to the destruction of corn and other grain by crows is the damage to melons, and upon this stomach analysis sheds practically no light. Complaints of this kind have come from practically all of the Southern States, as well as from a few points in the North. The crow's work on a melon patch is of a most annoying and destructive character, the damage being in the form of holes pecked into the melons. Most of the punctures are small, and after eating a little of the pulp and seeds of one melon the bird proceeds to another, where it inflicts like injury. In this way a comparatively few birds may do extensive damage. The following account by Dr. S. D. Judd[1] will give some idea of the extent and nature of the losses suffered:

> The only fruit grown for market that suffered from the depredations of the native birds was the melon, and it was attacked by one species only—the crow. In numbers from three to four to a dozen at a time, crows began to injure melons about August 1 and continued for three weeks, attacking both watermelons and canteloupes, but preferring the former. Each crow would peck at a melon a dozen times or so and then pass on to another. If no protective measures had been taken, the crop would often have been a total loss, and, in spite of all efforts, from 5 to 20 per cent of the melons grown at all distant from buildings were punctured. (1895–1902.)

The injury to ripening apples is at times considerable and of a nature not easy to prevent, especially in large orchards. This fruit was identified in 10 stomachs. A letter from T. A. Farrand, of Eaton Rapids, Mich., in this connection, reads:

> The newest thing that I know about the crow and how destructive it can be in a short time was in an apple orchard of which I have control near Ann Arbor, Mich. A year ago last fall, when harvesting the apples in one end of the orchard, we noticed large numbers of crows in the other end when we came to work in the morning. After the second occurrence my curiosity was aroused and I went to investigate. I found bushels of very fine apples ruined by their pecking into them. One variety, "Jonathan," was their choice. It was the first instance that I ever heard of. It did not occur this year. (1912.)

Maj. Allan Brooks, of Okanogan Landing, British Columbia, adds the corroborative evidence that "crows at the coast (both species) also do great damage to ripe apples on the trees" (1912), and H. L. Felter, of Washta, Iowa, has written that "crows pick off apples apparently just to see them fall to the ground. One man thinks they picked off 100 bushels." (1911.)

Reports from time to time have been made of injury to potatoes, especially when sprouting. One instance was recorded a few years ago at Cape Ann, Mass., where a potato patch, newly planted, was attacked by crows. One side of the field had been ravaged by them, the potatoes being left on the ground after they were dug up. The other side of the patch was "lined" with cotton string and two crows were shot and hung up there, but a week later all but a few of the seeds that were in hills beneath the string had been dug up.[1]

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[1] Birds of a Maryland Farm: Bull. 17, Biological Survey, U. S. Dept. Agr., p. 57, 1902.

Complaints that the crow damages crops other than those mentioned have occasionally come to attention. Among these are peanuts, beans, peas, figs, oranges, grapes, cherries, and such marketable nuts as almonds, pecans, and chestnuts. Among these the most extensive damage appears to have been done to peanuts, pecans, and almonds.

One observer in South Carolina asserts that it was almost impossible to grow peanuts in his locality. George A. Blair, of Mulvane, Kans., while making certain inoculation experiments with peanuts, suffered severely from crows. He said:

> I could not call this a test, as the crows practically ate up the crop. We were busy picking up apples and they took advantage of us and practically ruined the crop so that we could not dig the nuts. (1906.)

W. S. Cruzan, of Sulphur Springs, Tex., has said that—

> they [crows] gather the pecan nuts and eat them, also storing them for future use. They will often fly from a pecan tree with nuts to a place on the prairie near some bushes or weeds, and deposit a little pile of nuts, often as much as a pint or more.[2]

D. D. Stone, of Oswego, N. Y., states that—

> crows are great lovers of chestnuts and do lots of mischief in chestnut groves. stealing the nuts from the burrs that are open. They prefer to take them from the burrs, but sometimes alight on the ground for the fallen ones. A few miles south of here are many chestnut groves, and in fall the crows are more numerous there than here. (1911.)

At Davis, Cal., B. S. Brown reports that—

> the greatest damage is done to the almonds. They [crows] pick the nuts off the trees and beat them against a rock or tree until they break open. At this time of the year (January) they are in the old orchards picking up the waste nuts. (1912.)

Concerning their depredations on peas, John H. McCluer, of Franklinville, N. Y., submitted the following:

> The crows first begin on peas when the new pea in the pod is fairly well formed, say one-quarter grown, and continue until ripe enough for canning purposes. They eat pods and all in the young growths, but shell the pea as soon as the pod toughens a little. To my personal knowledge they have so attacked three fields lying on different farms, but so near together that it is possible if not probable the work was done by the same flock of crows. (1901.)

William L. Finley reports from Oregon that—

> in the Willamette Valley the crow does considerable damage to the cherry crop. but the birds are easily frightened from the trees. If unmolested they will soon strip a tree. (1911.)

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[1] Forest and Stream, LVIII, p. 285, April 12, 1902.

[2] Bull. Wilson Orn. Chap. Agassiz Association, II, No. 5, p. 12, Mar. 15, 1895.

From Orlando, Fla., comes information contributed by D. J. Nicholson that "crows at times do immense damage to the oranges. This occurs in the winter when they congregate in bands of 50 to 100." (1911.)

Injury to these various crops is not so serious or extensive as that inflicted upon corn and other grain. Nevertheless damage is liable to occur at most unexpected times and upon crops difficult to protect. Such raids are most frequently made by a number of birds upon single exposed fields or orchards, and result in heavy losses to individual farmers. From their particularly annoying nature, these activities should be charged against the crow in a consideration of his economic worth, even though the aggregate damage throughout the country may not be great.

WILD FRUITS.

Under primeval conditions wild fruits doubtless formed over half the annual food of the crow. But the advent of man with his introduction of corn so greatly altered the relative availability of this natural food supply that at present it constitutes less than 14 per cent (13.96) of the bird's yearly sustenance. May is the month of least consumption, when it formed only 3.49 per cent of the food. From this point a gradual increase was noted until September, when over a fourth (25.82 per cent) of the bird's food was secured from natural sources. October was also well represented (20.50 per cent), but in November and December considerably less was eaten (12.94 and 14.75, respectively). In January and February apparently the diminution in the available supply of corn again compels the crow to resort to wild fruit. In each of these months it totaled nearly a fifth of the food (19.76 and 19.57 per cent, respectively). The reduction recorded in March (10.65) and April (5.06) is due to an increased supply of animal food which becomes available with the advent of warmer weather. Of the 1,340 adult crows examined 576 had fed on wild fruits.

Stomach analysis reveals the fact that mast, from a variety of sources, but mainly acorns and chestnuts, furnishes the main supply of vegetable food secured from natural sources. Such food was recorded in 293 stomachs. Various sumacs, both poisonous and nonpoisonous, are especially favorite items and constitute an important part of the crow's limited rations late in winter, when the supply of many other wild fruits has been exhausted. Seeds of nonpoisonous sumacs were found in 246 stomachs. Among these, those of smooth and dwarf sumac (*Rhus glabra* and *R. copallina*) seemed most popular. Poison ivy (*Rhus radicans*) occurred in 66 stomachs and poison oak (*Rhus vernix*) in 18. The consumption of the latter two noxious plants involves the crow rather unfavorably in the problem of seed distribution, a discussion of which is presented on pages 68 to 71. The bayberry (*Myrica carolinensis*) and the wax myrtle (*M. cerifera*) furnish subsistence for many crows along the Atlantic coast, and in the southern part of this region the greenbrier (*Smilax* spp.), grapes (*Vitis* spp.), the Virginia creeper (*Parthenocissus quinquefolia*), sour gum (*Nyssa sylvatica*), and dogwoods (especially *Cornus florida*) are important food items. Wild cherries (especially *Prunus serotina* and *P. virginiana*) and plums present in 62 stomachs, strawberries in 50, and mulberries, blackberries, and raspberries in a fewer number were eaten during the rather brief fruiting seasons of these plants. The Juneberry (*Amelanchier* spp.) is a favorite food of the crows inhabiting parts of the northwest coast, though there are numerous records of such feeding in other regions as well. Blueberries (*Vaccinium* spp.) and elderberries (*Sambucus* spp.) must also be classed among the more important wild fruits upon which crows feed. Seeds of the following trees and shrubs also were taken from stomachs: Red cedar (*Juniperus virginiana*), beech (*Fagus americana*), hackberry (*Celtis* sp.), barberry (*Berberis* sp.), currants (*Ribes* sp.), haw (*Cratægus* sp.), holly (*Ilex opaca*), supple-jack (*Berchemia scandens*), buffaloberry (*Lepargyrea* spp.), and huckleberry (*Gaylussacia* sp.).

The mere consumption of wild fruit by the crow involves nothing of economic importance, since practically none of the embryos of the seeds are thus destroyed; but the fact that the crow, for that very reason, becomes an important distributor of certain noxious plants, necessitates a careful consideration of the bird's capabilities in this respect. (See pp. 68–71.)

GRASS AND WEED SEEDS.

Plants popularly classed as weeds are affected in no appreciable way by the seed-eating habits of the crow. Weed seeds formed only 1.36 per cent of the annual food of the 1,340 adult crows examined. That the percentage is even this high is explained by the fact that in February, when only 69 stomachs were available, several were practically filled with vegetable débris associated with a few weed seeds, all of which was classed under this head. This material would probably have been better designated as rubbish picked up unintentionally with carrion upon which also these birds were feeding. Thus interpreted, the weed seeds eaten would scarcely exceed half of 1 per cent of the yearly food.

Various knot weeds (*Polygonum* spp.) occur most frequently, and the seeds of the two foxtail grasses (*Chætochloa glauca* and *C. viridis*) scarcely less so. Seeds of ragweed (*Ambrosia artemisiæfolia*) are liable to be picked up at any time. The minute seeds of pigweed (*Amaranthus* and *Chenopodium*), so abundant in waste places, are so small that it is doubtful whether they are ever taken intentionally. Pokeweed (*Phytolacca decandra*) was present in only 8 stomachs, but from the débris found at roosts in the vicinity of Washington, D. C., it is apparent that the seeds of this plant form an important part of the winter food of the crows of that region. Such noxious plants as poison ivy and poison oak are discussed under the heading "Wild Fruits," on page 53.

FOOD OF NESTLING CROWS.

For several reasons a correct understanding of the food habits of nestling crows is essential to a complete consideration of the economic status of the species. These young birds, which average approximately four to a brood, remain in the nest for about three weeks, during which time they consume an immense quantity of food. According to Forbush,[1] fully fledged young crows will eat daily a quantity equal to at least half their own weight, and doubtless in the earlier days of their existence this ratio is greatly exceeded. When a normal number of young are raised they will outnumber the adults nearly 2 to 1 throughout most of the United States during the month of May. This fact is especially important, inasmuch as the height of abundance occurs at the time of appearance of some of the most destructive insects, which, if unchecked, would lay heavy toll on the season's crops. Then, too, the nestling life of the young crow coincides with or slightly precedes that of many small insectivorous birds, upon the eggs and young of which it is sometimes fed. Poultry raisers can attribute most of their losses in eggs and young chicks to the zeal of parent crows in providing food for hungry young rather than to a desire to satisfy their own appetites, since this could be done more safely at a greater distance from the farmhouse. Growing crops, also, especially sprouting corn, are at a critical stage of development at this time, and, should these be selected as food for nestling crows, the damage would be of a most serious nature.

Fortunately an excellent series of stomachs, 778, is available for a consideration of the food of nestling crows. Of these, 47 were secured late in April, 653 in May, and 78 early in June. They were collected in 14 States, the District of Columbia, and Canada, the largest numbers being taken in Kansas, Missouri, Maryland, and the District of Columbia. The birds ranged in age from the blind and naked young of a day or two to the fully fledged bird weighing almost as much as its parents and capable of consuming considerably more food.

The elements of the diet of nestlings are essentially the same as those of adults, though the relative percentages differ considerably. The food habits of the nestlings themselves also vary from the period when, a day or two old, their tender-walled stomachs require such soft, digestible food as spiders and caterpillars, to the time when, fully fledged, they relish hard-shelled beetles, crustaceans, small mammals, and grain, a diet differing but slightly from that of the parents. The series of stomachs examined includes young of all ages, and, as the various stages of growth are about equally represented numerically, the percentages derived may be considered as approximately a true average for the nestling. A diagrammatic representation of the food of these young birds is presented in figure 3 and a tabular statement showing percentages is given in Table IV, below.

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[1] Forbush, E. H., Useful Birds and Their Protection, p. 47, 1907.

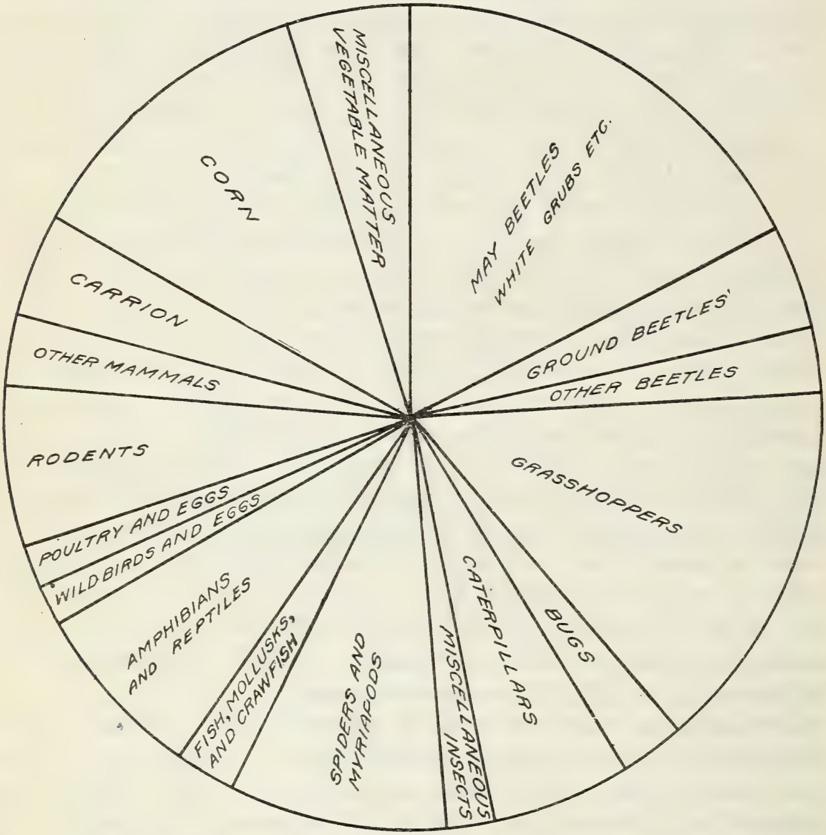

FIG. 3.—Food of nestling crows. The proportions of the various elements are represented by the relative sizes of the different sectors. Table IV presents the same information in percentages.

TABLE IV.—*Percentages of the principal food items of the nestling crow.*

May beetles.	Ground beetles.	Other beetles.	Grasshoppers.	Bugs.	Caterpillars.	Miscellaneous insects.	Spiders and myriapods.	Crawfish.	Fish and mollusks.	Amphibians and reptiles.	Wild birds and eggs.	Poultry and eggs.	Rodents.	Other mammals.	Carrion.	Corn.	Miscellaneous vegetable matter.
17.44	3.90	2.59	14.60	2.61	5.34	1.88	9.68	1.78	0.68	7.04	1.57	1.60	6.22	2.61	3.95	11.91	4 58

Animal Food.

INSECTS.

Animal food comprised 83.49 per cent of the diet of the nestling crows examined, insects forming the major portion, 48.36 per cent. Nearly half of this, 23.93 per cent, was composed of beetles, slightly less than the corresponding percentage in the diet of adults during May.

Coleoptera.

SCARABÆIDÆ.—Scarabæid beetles, most of which were May beetles (*Phyllophaga*) were the most important coleopterous remains found in the nestlings' stomachs. In bulk these beetles and their larvæ, white grubs, formed 17.44 per cent of the food, about 3 per cent less than in the diet of the adults during the same period. While both in percentage of food and number of individuals eaten the adult crow consumes more May beetles than its young, the importance of such food eaten by the latter must not be overlooked. For instance, each one of a brood of three nestlings collected in Wisconsin had been fed entirely on these insects. Five young taken in the District of Columbia had subsisted to the extent of nearly three-fourths of their food on adult May beetles, an aggregate of about 70 individuals being consumed by the brood. Another hatch of three secured in Maryland had fed on them to an extent of 84, 98, and 80 per cent, respectively, of their food. Stomachs collected at Onaga, Kans., in May of 1913 and 1914, revealed the remains of these beetles and their larvæ in remarkably large numbers. A series (three broods) of 12 nestlings, three-fourths grown, had eaten a total of 301, an average of over 25 apiece, along with several *Euphoria*, *Phanæus*, *Canthon*, *Geotrupes*, and other scarabæids. One of these had eaten 53, the highest number of May beetles recorded for a young crow. Another group of 17 (four broods) had destroyed 344, an average of over 20 apiece. Six others (two broods) had made away with 135 beetles. Of a total of 359 stomachs of nestling crows collected at Onaga, Kans., in 1913 and 1914, 285 contained remains of May beetles or their larvæ. The 64 beetles eaten by a brood of three secured in Dallas County, Mo., are interesting in that they include no less than nine distinct species. Of the larvæ (white grubs), young crows eat a much larger proportion than do the parent birds, but in no case did the numbers eaten equal those of the adult beetles consumed. A brood of three partly feathered young secured in Kansas had eaten 34, 28, and 23 white grubs, respectively, two others had taken more than 20 apiece and six others more than 10 apiece.

Other phytophagous scarabæids similar to those eaten by the adults are also fed to the young (see p. 13). Euphorias were found in numerous stomachs, in each of two instances 10 individuals being eaten. The carrot beetle (*Ligyrus gibbosus*) and others of the same genus occurred frequently in stomachs from Kansas and Missouri, though in no case in large numbers. June bugs (*Cotinis nitida*), vine chafers (*Anomala* spp.), goldsmith beetles (*Cotalpa lanigera*), and other related forms were found now and then in the nestling stomachs. The dung-inhabiting scarabæids (Laparosticti), are eaten by young crows frequently, though the small size of some, as *Aphodius*, prevents their forming an appreciable portion of the food. Tumblebugs (*Canthon* and *Geotrupes*) occurred very regularly in material from Kansas, in some instances as many as a dozen of these large beetles being present in a single stomach. *Copris*, *Onthophagus*, and *Phanæus carnifex* also were found.

CARABIDÆ.—Ground beetles formed 3.90 per cent of the food of nestlings compared with 5.54 per cent for the adults during approximately the same period. Of the caterpillar hunters, *Calosoma calidum* was most often fed to the young, 46 of the 778 nestlings having eaten one or more individuals. *Calosoma externum*, a still larger form, was found in numerous stomachs from Kansas, while the brightly colored and malodorous *C. scrutator* was present in 24 stomachs. Of the large ground beetles, the broad *Pasimachus* was most commonly fed to nestlings. This is especially the case in young secured in Missouri and Kansas. A brood of four, partly feathered, taken at Onaga, Kans., had eaten 17 of these large beetles, along with 3 *Calosoma externum*, 7 *Chlænius*, 2 *Scarites*, and one other ground beetle. They were present in about two-fifths of the stomachs taken in this locality, while of the total number of 778 nestlings 139 had subsisted upon them. Various other ground beetles, *Scarites*, *Harpalus*, *Evarthrus*, *Pterostichus*, and *Amara*, were present in approximately the same proportions as in stomachs of adult crows. At times, when the young were fed on members of several genera, the total number eaten was considerable. One partly feathered young had eaten no less than 60 individuals of the genera *Chlænius*, *Anisodactylus*, *Cratacanthus*, and *Scarites*.

RHYNCHOPHORA.—Nestling crows eat very few weevils. As in the case of the adults (see p. 18) the clover-leaf weevil (*Hypera punctata*) and the imbricated snout-beetle (*Epicærus imbricatus*) are the only ones worthy of note. The former was present in 32 of the 778 stomachs. One collected in Maryland contained 18 of these weevils along with 8 *Epicærus;* and another, secured in New York, had made away with 11. Imbricated snout-beetles were present in 126 stomachs, in two instances as many as 32 individuals being recorded. One of the latter two was collected in Maryland and the other was of a hatch of five secured in the District of Columbia, each one of which had fed on these insects, a total of 62 weevils having been eaten by the brood.

OTHER BEETLES.—Other beetles fed to nestling crows belong mainly to the necrophagous and coprophagous families Silphidæ, Staphylinidæ, and Histeridæ. The proportion of these insects eaten is essentially the same as in the food of adults. No instance of extremely large numbers eaten was recorded. Click beetles (Elateridæ) and their larvæ, wireworms, form only a small portion of the nestling's food, about a third of 1 per cent, and in no stomach were remarkable numbers noted, an odd circumstance in view of the favorable reports made by competent field observers regarding the crow's effectiveness as an enemy of these pests.

Orthoptera.

In the destruction of grasshoppers, nestling crows render man a most important service. Although the birds are reared prior to the season when these insects are most abundant a vast number of the nymphal forms fall as their prey. More than 14.5 per cent of the food of those examined consisted of orthopterous remains—a remarkable proportion when it is considered that adult crows at the height of the grasshopper season in August and September take only a little over 19 per cent, and during the nestling period (May) only 4.29 per cent. It is highly probable, though, that this percentage for nestling crows is somewhat exaggerated because of the large numbers collected in Kansas and Missouri. On the other hand, no nestling material is available from the extreme Northwest, an area in which adult crows feed extensively upon these insects. Nestling crows in that region no doubt are fed largely upon Orthoptera.

By far the largest portion of orthopterous food of young crows consists of short-horned grasshoppers (Acrididæ). These were present in 528 of the 778 stomachs examined, and in many exceedingly large numbers were recorded. When it is considered, however, that the number of grasshoppers eaten is determined by counting the jaws present, and that these undigested parts are in many cases accumulated from past meals, the large numbers recorded are partially explained.

The most noteworthy work of grasshopper destruction revealed in the examination of stomachs of nestling crows was that of a brood of four secured at Onaga, Kans. These had eaten 133, 106, 105, and 74, respectively, a total of 418, which constituted three-fourths of the food. Another brood of seven had consumed a still greater number, 585, but they averaged only about 83½ for each bird and formed a little less than 70 per cent of the stomach contents. One of these nestlings had eaten 143, the highest number recorded for a single crow, young or old. Four partly feathered young, also from Kansas, had devoured 259 grasshoppers; another brood of four made away with 222; and a series of nine, made up of probably two broods, averaged 50 apiece. Seven other individual nestlings had eaten 50 or more; 31 had taken from 25 to 49; and 44, 10 to 24 apiece. Frequently grasshoppers were associated with locustid or cricket remains, the combined bulk often forming the major portion of the food. In one stomach orthopterous insects formed the entire contents, in 35 they constituted from 75 to 99 per cent, and in 49 others they composed from 50 to 74 per cent.

Two series of young crows from Onaga, Kans., one of 157 taken in 1913 and another of 164 secured in 1914, revealed interesting data regarding the relation of these birds to grasshoppers in years when the insects are abundant. In working up this material, it was noticed that in the former year grasshoppers were by far the most important item of the diet, forming 42 per cent of the food and occurring in 151 of the 157 stomachs. In 1914 these insects constituted less than 12 per cent of the food and were present in 123 of the 164 stomachs, in many of which merely a "trace" was recorded. It was in the material taken in 1913 also that all the phenomenal records mentioned above were noted. In 1914, only 7 of the entire lot of young crows examined subsisted on grasshoppers to the extent of more than half their diet. Facts which can be correlated with this wide difference in the food of crows in the same locality in two successive years have been obtained from W. R. Walton, of the Bureau of Entomology, who has stated that, although 1913 was not a year of extraordinary abundance of grasshoppers in Kansas, 1914 was a season of uncommon scarcity, especially in spring and early summer. Exceedingly heavy rainfall is the reason assigned for lack of normal numbers. The importance of young crows as a factor in grasshopper control during an outbreak of the insects is a matter of interesting conjecture.

Lepidoptera.

Caterpillars occurred in more than a third of the stomachs of nestling crows and formed 5.34 per cent of their food. These soft, easily digested larvæ are among the first items fed to newly hatched young, but as the birds grow older other insect forms soon displace them in the diet. Birds which had been fed most extensively on them were, as a rule, less than 4 days old. A brood of four, 1 to 2 days old, collected at Onaga, Kans., had eaten over 300. Two of another brood, 3 days old, taken at the same place, had devoured 115 and 109, respectively. One partly feathered nestling had been fed over 100, and another 92. Large numbers also were found in each of four stomachs of another brood 2 days old, but owing to the advanced stage of digestion, their number could be estimated in only one. This stomach contained 60. In comparatively few cases, though, did caterpillars constitute a large portion of the bulk of the food. One newly hatched nestling had eaten 20, which completely filled its stomach. Another, nearly ready to leave the nest, had its stomach 97 per cent full of the skins and finely-chewed vegetable food of two large caterpillars. A brood of three had subsisted on caterpillars to the extent of 87, 60, and 47 per cent, respectively, of their diet. In six other instances these insects made up over 60 per cent of the food. As in the case of the adult crows, cutworms (Noctuidæ) were found most frequently. The silken cocoons and pupæ of some of the larger moths are not uncommon ingredients of the food. In the stomach of one nestling 110 lepidopterous eggs were found.

Hemiptera.

Bugs of various kinds constituted 2.61 per cent of the food of these young birds, approximately three times the quantity taken by the parents. Of the true bugs (Heteroptera) the nestlings' share is essentially the same as that of the adults. In choice of forms eaten their taste is quite similar (see p. 23). Stinkbugs (Pentatomidæ) are the ones most often found, but in no case were they taken in large numbers. Among the Homoptera, one species, the periodical cicada, or seventeen-year locust (*Tibicen septendecim*), stands out prominently. The series of 157 nestlings secured at Onaga, Kans., in 1913, were collected just prior to the emergence of a brood of these odd insects. This brood, designated as Number IV,[1] was common in the area in which this material was secured, its range covering eastern Kansas and western Iowa and Missouri. Sixty-eight of the 157 young crows secured at this place in 1913 had fed on cicadas, nearly all of which were probably the periodical form, though accurate identification was impossible in many cases, as the insect was eaten in the pupal stage, and digestion soon obliterated important characters. A brood of 7 partly feathered crows had been fed on no less than 168 of these pupæ, one individual taking as many as 49. One from another brood had eaten 41. A series of 9, probably 2 broods, made away with 200. Eight other nestlings had devoured over 10 apiece. That these insects at times comprise a substantial part of the volume of food eaten is shown by 20 young (4 broods), which had subsisted on them to the extent of 31.3 per cent of their food. Each one had fed on cicadas and in one case they comprised 60 per cent of the stomach contents.

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[1] Marlatt, C. L., The Periodical Cicada: Bull. 71, Bur. Ent., U. S. Dept. Agr., p. 43, 1907.

Other insects.

Other orders of insects are poorly represented in the food of nestling crows. As in the case of the food of adults, craneflies (Tipulidæ) are the most important of the Diptera. Of bees, ants, and wasps (Hymenoptera), young crows take only a small quantity, 0.73 per cent, but include many of the species listed under the food of adults (see p. 24). Other insect forms occurred in only negligible quantities.

SPIDERS.

Spiders constitute one of the most important food items of the young crow during the early days of its existence. In fact for the whole period of its nestling life these creatures form nearly a tenth (9.68 per cent) of its diet. They were present in 471 of the 778 stomachs, in many of these high percentages being recorded. One newly hatched bird had subsisted on spiders alone; in 7 stomachs they comprised over 90 per cent of the food; while in 32 additional stomachs they formed over half of the contents. No instances of very large numbers occurring in single stomachs were noted, 3 or 4 of the large wolf spiders so frequently eaten usually being sufficient to satisfy all needs. In only 4 cases were more than 10 spiders eaten; the highest record—15—was that of a callow young bird. The avidity with which very young crows eat these arachnids is well shown by the following summary: One hundred and twenty-six nestlings, ranging in age from 1 to 4 days, and picked indiscriminately from the material at hand, had been fed on spiders to the extent of a little less than a fourth of the food (24.5 per cent); in 80 others, 5 to 9 nine days old, spiders formed 11.6 per cent; and in 125, 10 or more days old, only 4.8 per cent of such food was recorded. In the first of these three groups only 8 of the 126 failed to have at least a trace of a spider in their stomachs; in the second series 12 out of 80 did not feed on them; while in the third lot, including many birds that were fully fledged, only about half (59 of 125) had taken them. In feeding on the different families of spiders, young crows followed closely the preferences exhibited in the food of their parents (see p. 25).

CRUSTACEANS.

The greater part of the crustaceans eaten by the young crows examined consisted of crawfish, which were taken in approximately the same quantity (1.78 per cent) as recorded for the parent birds during the same period. One nestling secured in Illinois had its stomach practically filled (98 per cent) with this food, and in 27 others these crustaceans made up more than one-fifth of the stomach contents. A few other crusteceans similar to those found in the stomachs of adults also were eaten by the young (see p. 26).

MOLLUSKS AND FISHES.

Mollusks and fishes constitute an unimportant portion of the food of nestling crows, being negligible both in quantity (0.68 per cent) and in economic significance. Mollusks, most of which were land snails, were found only occasionally. Fish remains occurred more frequently, but it is evident that the consumption of such food is controlled largely by local conditions. Young secured in Dallas County, Mo., had eaten more than any others. Each individual of two broods of five and three, respectively, collected there, had fed on fish, which constituted about 17 per cent of the diet. This is the most extensive work of the kind noted among nestlings.

REPTILES AND AMPHIBIANS.

Reptiles and amphibians, in about equal portions, comprised 7.04 per cent of the food of nestlings. Reptiles occurred in 231 of the 778 stomachs, and, as in the case of the adults (see p. 28), snakes made up the bulk. These were found in 140 of the 231 stomachs in which reptiles occurred. A fully fledged young crow secured in Wisconsin had its stomach filled with the vertebræ and other bones of a small snake, and in nine other cases such food formed over three-fourths of the contents. Ofttimes it was apparent that parts of a large snake or turtle had been passed to several members of a brood; in fact this procedure appeared to be the rule rather than the exception, and a few cases were noted where every member of a family, old and young, apparently had shared with the others some particularly highly prized morsel. The eastern ring-necked snake (*Diadophis punctatus*) and a blue racer (*Zamenis constrictor*) were the only reptiles specifically identified in these stomachs.

Toads, frogs, and salamanders were present in 208 of the 778 stomachs, a much higher proportion than in stomachs of adults, where only 153 of 1,340 contained such food. In over half of these (110) the remains of frogs (Ranidæ) were identified, in 13 there were toads (Bufonidæ), and in 53, salamanders. Doubtless additional members of one or another of these groups were among the material which was too far advanced in digestion to be identified other than merely as amphibian. In most instances the feeding was confined to an individual toad or frog, and often parts of the same animal would be passed to one or more of a brood. In fact, this was so frequently the case among nestlings that while amphibians were present in 208 stomachs, the actual number of individuals taken was somewhat less.

A brood of four secured in Michigan illustrates this point. Notwithstanding the fact that frog remains occurred in the stomach of each and averaged over 50 per cent of the food there was no evidence that more than two individuals had been eaten. Each of another brood of five collected in Vermont also had frog remains in its stomach and, as the average portion for the lot was only 18 per cent of the stomach contents, one frog may well have furnished the food for all. Two half-grown young, also from Vermont, had eaten a toad, frog, and salamander between them, which constituted 51 per cent of their diet. Another week-old hatch of three from the same place also had the remains of probably one frog shared among them. Five young secured in Dallas County, Mo., had all fed on frogs and toads, probably three or four individuals being eaten. Each of five others from the same place had fed on amphibians, a salamander and more than one frog being identified. In one instance, where even the skin of a freshly eaten specimen was still present in the stomach, the frog remains formed as much as 83 per cent of the food.

WILD BIRDS AND THEIR EGGS.

The remains of wild birds and their eggs formed 1.57 per cent of the food of nestling crows. Birds were found in 53 of the 778 stomachs, but in four cases the material could not be distinguished from the remains of poultry. Eggs of wild birds were present in 20 stomachs. In two instances the remains of both a wild bird and eggs were found in the same stomach, so the total record of such carnivorous habits on the part of nestling crows amounts to 71 out of 778 stomachs, an average of about 1 in 11. This ratio, when compared with 1 in 28½ for the adult, probably closely represents the relative activity of old and young in the destruction of bird life.

As in the consumption of other vertebrate remains, crows frequently feed parts of the same individual to more than one nestling, which results in duplication when a count is made of the number of stomachs in which certain items are found. A brood of 4 or 5 may each have fed on the body of a nestling robin, yet only one act of vandalism on the part of the parent supplied the food. Although 71 young crows had partaken of wild birds or their eggs, only 44 broods were involved. While in a few instances more than one bird or clutch of eggs may have been present in the stomachs of one brood, the habit of passing around parts of the same individual seemed to be common. It is apparent, then, that the ratio of 71 to 778 is an ample one and that it may be reduced even more than has been indicated when it is considered that in several cases the parents of the broods also had shared with their young parts of the same food.

Each one of a brood of four collected in Kansas had been fed on what appeared to be a song sparrow, and two of the four stomachs contained fragments of a small eggshell. Another brood of four from the same place apparently had divided a single small passerine bird between them. In two other cases were the remains of apparently one bird eaten by all of a brood. The stomach linings of these victims are among the most indigestible parts, even persisting longer than bone fragments, and at times fragments of this sac will constitute the only evidence of the deed done. In the stomach of a half-grown crow from Kansas was found the stomach lining of a small bird, intact and filled with food in a condition satisfactory for examination.

A consideration of the economic problems involved in the eating of wild birds by the crow and the testimony presented by field observers on this point is given on pages 29–36.

POULTRY AND THEIR EGGS.

Poultry and their eggs, occurring in 70 of the 778 stomachs of nestling crows, formed 1.60 per cent of the bulk of the food. In 50 of these the remains were of poultry, and in 21, eggs, one stomach containing both. The ratio of 70 out of 778 (about 1 to 11) is greater than that for the adults (about 1 to 21), but this is to be expected in view of the fact that nestling crows are fed extensively on vertebrate food, amphibians, reptiles, and wild birds, all being found more frequently in the stomachs of young than in those of adults. Field observations also have established the fact that it is the nestling which is primarily to blame for losses to the poultry raiser, as the extermination of a single offending brood will often put a stop to depredations. The records of such depredations on the part of nestlings are somewhat reduced by the fact that while 63 young had been fed on such food only 37 broods were involved, indicating that the parent birds frequently passed the especially palatable tidbits to all the family. In one or two cases the adults themselves joined in the feast.

Each of a brood of three secured in Dallas County, Mo., had been fed on one or more hen's eggs, though in bulk the shell formed only 3 per cent of the stomach contents. Three of another brood from Maryland also had their hunger appeased with similar food. Still another lot from the same State were particularly well fed at the expense of some poultry raiser. Each bird had been fed on chicken, which constituted over 40 per cent of six well-filled stomachs. Five half-grown young from Kansas had apparently all fed on a chicken, though accurate identification of the bird remains could not be made in two of the stomachs. Three of another brood of four from the same place also had partaken of similar food, which formed 44 per cent of their diet. Apparently more than one hen's egg was eaten by three of four nestlings from the District of Columbia, as fragments of the shell made up nearly 17 per cent of the stomach contents.

A discussion of the economic aspects of this part of the crow's food habits is presented under "Food of Adult Crows" on page 36.

SMALL MAMMALS.

The efficiency of the crow in the control of mammal pests, in which it ably supplements the work of birds of prey, is occasioned largely by the food habits of the nestlings. Over a twelfth (8.83 per cent) of the food of young crows consists of mammals, the major portion of which (6.22 per cent) was found to be injurious rodents. Remains of mammals were discovered in 378 of the 778 stomachs, and of these 145 contained the pests mentioned.

As in the case of the parent birds, cottontail rabbits are the favorite mammal food of young crows, being found in 67 stomachs. Nestlings secured in Kansas were especially well fed on cottontails. At times all or nearly all members of a brood would have their stomachs distended with such food. Five partly feathered young of the same nest secured at Onaga in early May had all fed on one or more rabbits, which formed an average of 65 per cent of their diet. Each one of another brood of five from the same place also had partaken of a cottontail, but in this case the remains formed about half the stomach contents. Two more broods of three and four each had their stomachs nearly two-thirds full of such food. In several other instances also the remains of cottontails appeared in all the stomachs of one brood, but in none did they constitute over half the food. It frequently happened that each member of a brood had to be examined before conclusive evidence as to the origin of the flesh or hair which occurred in all could be obtained. The young of these mammals are torn to pieces before being fed to nestling crows, so that the investigator is often compelled to postpone definite identification of the food of a series of stomachs until the one containing a tooth, parts of a skull, or other diagnostic bones is opened.

Meadow mice (*Microtus*) were present in 17 of the 778 stomachs. In three broods of three each these rodents were eaten by all individuals, forming 36, 14, and 12 per cent, respectively, of the broods' food. White-footed mice (*Peromyscus*) occurred in 15 stomachs. These entered into the food of all ten individuals of three broods. In the case of one of the broods of three the remains of white-footed mice formed nearly two-thirds of the stomach contents; in the brood of four they constituted 62 per cent. In the stomach of one nestling of a brood of five was found the entire body of a newly born *Peromyscus*, which doubtless had been dug from its nest. House mice (*Mus musculus*) were found in two stomachs, a jumping mouse

(*Zapus hudsonius*) in one, and a ground squirrel (*Citellus tridecimlineatus*) in another. Short-tailed shrews (*Blarina brevicauda*) (in two stomachs) and bats (in two stomachs) also were eaten by nestling crows.

A consideration of the economic aspects of the carnivorous habits of the crow in relation to mammals is presented on pages 38–40.

CARRION.

Carrion formed 3.95 per cent of the food of the nestling crows examined, as compared with 2.13 per cent for the adults during approximately the same period (see Table II). As it is frequently impossible to determine with absolute certainty the character of animal food, the proportion may be subject to revision. Remains of rabbits, chickens, and parts of larger carcasses have been included under this head.

Vegetable Food.

CORN.

Of the vegetable food of the nestling crow, which formed 16.53 per cent of the diet, corn is the most important item. Some farmers have considered that the depredations on this grain in sprouting time are due largely to the nestlings' desire for the soft, germinating kernel, but stomach analysis has disproved this. Corn was found to constitute 11.91 per cent of the young crow's food, a third of the proportion taken by the adult during approximately the same time. The frequency with which these young birds eat this grain, however, gives the impression that their capabilities in this direction are more nearly akin to those of their parents. Of the 778 nestling crows examined, 354 (45.5 per cent) had fed on corn, as compared with 824 (61.49 per cent) of the 1,340 adults.

The limited quantities of corn consumed by the nestlings can better be appreciated when it is considered only 68 of the 778 had subsisted on it to the extent of more than half their food. Almost invariably the stomachs containing large quantities were those of nearly fledged birds, the character of whose food habits was rapidly approaching that of the adults. Corn eaten by nestlings less than a week old is practically negligible in quantity.

SMALL GRAINS.

Grain other than corn forms a small portion of the food of the nestling crow, but additional material collected in the Northwest may reveal greater activities along this line. Only 7 of the 778 nestlings had fed on wheat, 11 on oats, and 4 on buckwheat.

OTHER VEGETABLE FOOD.

While vegetable matter other than corn forms 4.58 per cent of the food of nestling crows, over half of this (2.32 per cent) may properly be classed as rubbish. This material, composed of bits of rotten wood, grass fibers, and leaves inadvertently picked up by the parent birds along with food for their young, is readily swallowed by their ravenous offspring, who are not troubled by doubts as to the ability of their digestive organs to care for anything possessing the slightest semblance of food. The yearly total of material classed under the headings of grass and weed seeds, cultivated fruits, and wild fruits in no case formed as much as 1 per cent. The cultivated fruit eaten during the nestling period is largely waste from the preceding year, and while some of the wheat and oats may be from the sprouting crop, the quantity actually secured from such sources is negligible.

DISTRIBUTION OF LIVE-STOCK DISEASES.

Because of its carrion-eating habits, the crow has been accused, along with the turkey buzzard, of being a potent agency in the transmission of diseases of domestic animals. Complaints of this nature have come most frequently from the Southern and Southwestern States, and in some sections farmers have regarded the crow as a most unwelcome visitor in the vicinity of live stock. The alleged distribution of hog cholera has been the commonest criticism.

Doubtless the transmission of hog cholera by the crow is possible either through virus carried on the feet, bills, or other parts of the bird or through the deposition of infected excreta after the bird has been feeding on the body of an animal which died of the disease.

However, by the immediate burial of the dead bodies of diseased animals, and the employment of most rigid sanitary measures, the objects which usually attract these birds may be eliminated. The free use of disinfectants, covering all matter that might be of food value to the crow, together with the employment of some of the usual methods of frightening these birds, such as a network of strings over pens containing diseased animals, should prove effective means of keeping the birds from the premises and reduce the danger from this source to a minimum. It is well to remember that numerous agencies, including dogs, cats, and innumerable insects, are always at work in the spread of such diseases. Thorough methods of sanitation will tend to make these also innocuous.

DISTRIBUTION OF SEEDS.

Unlike those of our more granivorous species, as sparrows and gallinaceous birds, the stomachs of crows are not capable of grinding and assimilating hard seeds. Consequently, the food value of many

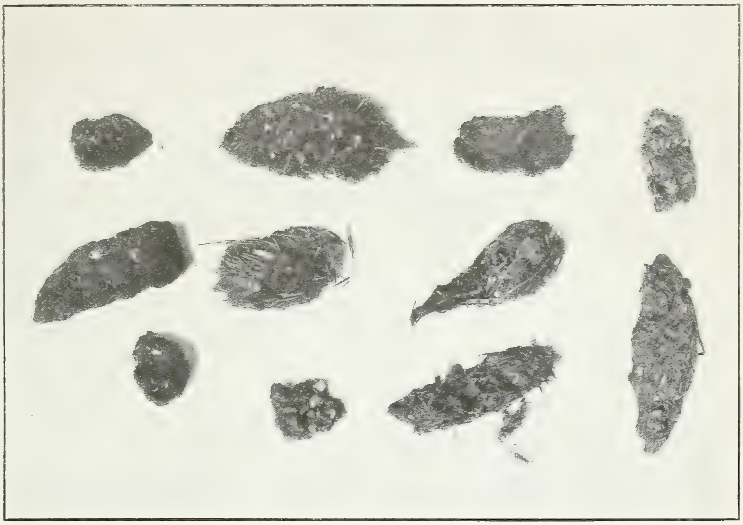

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FIG. 1.—CROW PELLETS

These consist of masses of undigested food and are disgorged in great numbers at winter roosts.

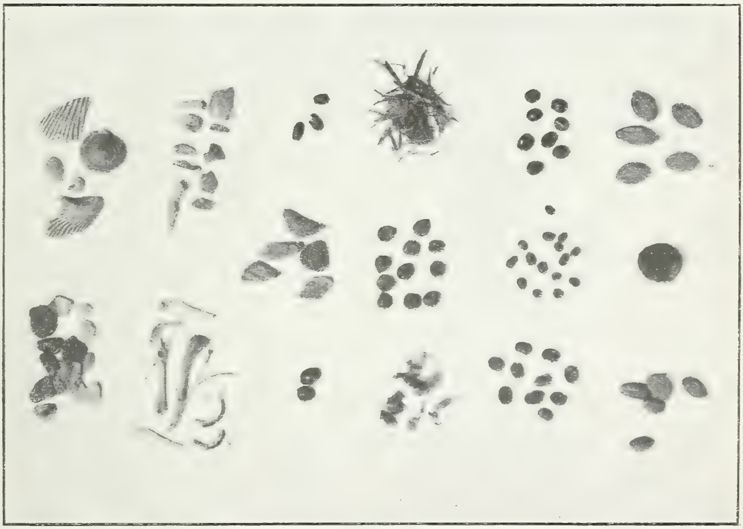

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FIG. 2.—CHARACTERISTIC INGREDIENTS OF CROW PELLETS.

Collected at the Woodridge, D. C., roost in February, 1912. Included are the wing covers of clover-leaf weevils, fragments of crawfish, land and marine mollusks, bones of a small rodent, fragments of larger bones (carrion), hulls of corn and wheat, seeds of greenbrier, sour gum, flowering dogwood, poisonous and nonpoisonous sumac, wild grape, knotweed, an acorn, and gravel.

wild fruits, as sumac, poison ivy, poison oak, bayberry, dogwood, sour gum, cherry, and juniper, ceases when the soft outer portion has been utilized. To aid even in this process of digestion crows swallow large quantities of sand, gravel, shell fragments, or anything else that will serve as a grinding medium. After a large number of such seeds have been eaten and the digestible portions assimilated, the remains are regurgitated. The fact that embryos of these seeds are seldom affected by this process, and that a large part of those disgorged are capable of germination, brings up the important problem of seed distribution.

The material so disgorged usually assumes an ellipsoid or spherical form, but is quite variable in size (Pl. II, fig. 1). These masses, commonly called pellets, as in the case of similar ejecta of birds of prey, are found in great abundance at crow roosts, and wherever a place has been occupied by these birds for several successive winters a substantial growth of their common food plants usually springs up.

An idea of the number of seeds deposited at one of these roosts may be gained from the following description given by Prof. Barrows:[1]

> The following facts serve to show how extensive is this seed planting by crows in the vicinity of the winter roosts: On February 8, 1889, I visited the well-known—almost historical—crow roost located on the Virginia side of the Potomac River just opposite Washington, D. C. The exact location of this roost varies from time to time, but at the date mentioned it was entirely within the grounds of the National Cemetery at Arlington, and covered an area of 12 or 15 acres of second-growth deciduous trees. The ground beneath these trees was pretty evenly covered with the ejecta of the crows, forming a deposit which in places was an inch or more thick, though the average deposit was probably rather less than half an inch. A representative spot free from underbrush was selected, and all the material above the leaves from an area 2 feet square was carefully collected, dried, and examined. The weight of this material when dry was almost exactly 1 pound, and it contained (aside from gravel, bits of bone, shell, corn hulls, and some excrement) the following seeds:

Poison ivy (*Rhus toxicodendron*)	1, 041
Poison sumac (*Rhus venenata*)	341
Other sumacs (*Rhus*)	3, 271
Juniper or red cedar (*Juniperus virginiana*)	95
Flowering dogwood (*Cornus florida*)	10
Sour gum (*Nyssa sylvatica*)	6
Total	4, 764

> A little calculation shows that the roost of 15 acres must have contained upward of 778,000,000 seeds, or more than enough to plant 1,150 acres as thickly as wheat is sown.

A series of nine pellets, gathered at a former roost near St. Louis, Mo., and examined by the writer, contained an average of 36 poisonous *Rhus* seeds (poison ivy and poison sumac) for each pellet. Along with these were seeds of nonpoisonous sumac, grapes, dogwood, hackberry, wild bean (*Strophostyles*), and buckthorn (*Bumelia*). A mass of material gathered at a roost near Baltimore contained 156 seeds of poisonous *Rhus*, estimated to be 25 per cent of the bulk of the pellets. These also contained 11 seeds of nonpoisonous sumac, 6 of greenbrier, 4 of juniper, and 1 of hackberry. W. L. McAtee, of the Biological Survey, has informed the writer that at the roost formerly located at Woodridge, near Langdon, D. C., he recorded the following species of plants in such abundance as to justify the belief that they had sprouted from seeds brought there by crows: Poison ivy, poison sumac, flowering dogwood, sour gum, arrowwood, and frost grape. He also stated that in 1 square yard there were 51 plants of poison ivy.

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[1] Barrows, W. B., The Common Crow of the United States: Bull. 6, Div. of Ornith. and Mamm., U. S. Dept. Agr., pp. 23–24, 1895.

The seeds deposited at winter roosts form only a portion of the material of this character cast up by these birds (Pl. II, fig. 2). These pellets are dropped here and there over the birds' daily feeding range, and under such circumstances probably a much greater proportion of the seeds sprout. Conditions in the average roost are not advantageous to the germination of a large part of the deposited seeds, especially in the dense pine woods so frequently chosen.

When the seeds thus distributed are of valuable trees and shrubs or even of harmless plants, the crow no doubt is performing a distinct service, but the dispersal of seeds of poison ivy and poison sumac must be considered undesirable. Examination of 1,340 stomachs of adult crows showed that seeds of these poisonous weeds constitute 1.49 per cent of the yearly food. Most of them are eaten during fall and winter, January being the month of greatest consumption (5.02 per cent). When it is remembered that practically all these seeds would develop into weeds of the most noxious character should they be deposited in a favorable environment, it is not surprising that the crow has been the subject of considerable criticism on this score.

While it must be admitted that no agency aiding in the reproduction of poisonous plants should receive encouragement, it will be well before being unduly severe on the crow to notice other factors working toward the same end. Records of birds' stomachs examined by the Biological Survey show that no less than 65 species of birds feed on the seeds of poisonous *Rhus*. Many of these birds possess the same objectionable habit of regurgitating the seeds, and in several cases the percentage of such food eaten exceeds that of the crow; but none of them leaves so large a part of the seeds of poison ivy and poison oak in places where they will never germinate as does the crow. The latter, then, is in a way conferring a benefit in feeding on these seeds, as by so doing it reduces the supply which otherwise would be available for more potent seed distributors. Nor in extending its range is poison ivy dependent entirely upon the transportation afforded by bird life. It readily reproduces itself through its roots and ofttimes spreads over considerable areas in spite of vigorous efforts to exterminate it. It is apparent, then, that even the total extermination of the crow would have little effect upon the growth of poisonous *Rhus*, inasmuch as there are many other agencies effecting the same results. The problem is one similar to that of the dissemination of live-stock diseases, the control of which some persons maintain can be effected by the elimination of crows and turkey buzzards, overlooking the fact that there are numerous other agencies engaged in the work of dispersal, and that the removal of only one or two would result in no appreciable relief.

NATURAL ENEMIES.

Aside from man the crow appears to have few natural enemies. His unusual wariness stands him in good stead in avoiding many of those mammals and birds which prey to a considerable extent upon bird life. The great horned owl alone seems to be inclined to feed on the crow as a more or less regular item of diet. Ample opportunity is afforded this species to secure such food at crow roosts, which it appears to frequent regularly for this purpose.

In this connection, E. H. Forbush, of Massachusetts, has said:[1]

> After the first fresh snowfall, I visited an extensive roost, finding the feathers and a few other remains of a freshly killed crow. At the spot where the crow was borne to the ground were the strong imprints of the characteristic tips of the wings of the great horned owl. These owls habitually take crows from their roosts or nests at night.

The antipathy between crows and owls as a class is frequently manifested in the "mobbing" of one of the latter by a large number of crows. Recognizing the comparative helplessness of these nocturnal birds of prey when subjected to bright daylight, the black fellows appear to take great delight in molesting them when they are found abroad during these hours.

G. B. Wellman, of Malden, Mass., reports:

> The chief thing that our crows in the fells seem to busy themselves with in the winter months is harassing the owls. They have in consequence driven nearly all the barred and screech owls from the park. There has been, I am sure, an added nuisance made here by the increase of the noxious rodents since the owls left.

Occasionally the red-tailed and red-shouldered hawks will turn upon their tormentors. Examination of stomachs by Dr. Fisher revealed six records of this work on the part of the former and one by the latter bird.

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[1] Forbush, E. H., Two Years with the Birds on a Farm, p. 39, 1908.

The attacking and driving away of crows by smaller species is a matter of common knowledge. This is especially true of the kingbird, which appears to maintain a sworn vengeance against its much larger relative. Its antipathy is most marked during the nesting season, when a pair or two of kingbirds are frequently an effective means of protecting poultry and crops in the immediate vicinity of their nests. In this connection, Maj. Allan Brooks, of Okanogan Landing, B. C., remarks, in a letter to the Biological Survey, that "the crows are generally kept away from the immediate neighborhood of houses and poultry yards by the number of kingbirds (two species) present." Though other small birds vigorously attack crows when the young or eggs are in jeopardy, none appears to possess to the same marked degree the unceasing animosity of the kingbird.

Probably the most important natural agency in the reduction of the number of crows is a disease popularly referred to as "roup." Though no exhaustive study of this malady has been made, a few points regarding its nature have been established. Technically it may be termed an ulcerative keratitis, in which there also appears an inflammation of the mucous membranes, accompanied by exudations from the eyes and nostrils. In severe cases the secretion about the eyes covers the cornea and blindness follows. Experiment has proved that the disease is contagious among crows, and also that it is specifically different from the roup of poultry.[1]

Heavy inroads have at times been made by this malady on the numbers of crows at their winter roosts. Becoming partially or totally blind in the advanced stages of the disease, the disabled birds suffer from lack of food and soon succumb under the combined attacks of disease, hunger, and cold, or fall easy prey to the predatory mammals and birds which take advantage of their helplessness. In one instance the writer witnessed a barred owl, closely pursued by a large flock of frenzied crows, making away with a sick individual too weak to resist.

Prof. E. H. Eaton, describing an outbreak of this kind, states:[2]

> About the middle of December, 1901, a malady broke out among the crows (*Corvus americanus*) of Ontario County, N. Y., which, ere spring, had decimated the ranks of the local "roost." As soon as winter had fairly begun reports commenced to come in of crows which had been "blinded by freezing of their eyes," as the farmers expressed it. * * *.
>
> All the sick birds were suffering from an acute inflammation of the pharynx and the anterior portion of the head, including the nostrils and eyes. Often there was a mucous discharge from the nostrils. The eyes were usually blinded by a membrane forming over the exterior of the cornea. Sometimes only one eye was seriously affected, and this was usually the left one, as far as I noticed. If this membrane was rubbed off the eye looked quite clear again

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[1] Information supplied by the Bureau of Animal Industry.

[2] The Auk, XX, pp. 57–58, 1903.

and sight was temporarily restored, but within half an hour the membrane reformed and the patient would flutter about like a bird with the cerebellum destroyed or with the eyes shot out.

That death ensued from the acute disease and not merely from starvation due to blindness was abundantly proved by caring for sick birds and forcing food down their throats, for they died in nearly every instance. While it is true that those birds which survived the disease were, in every instance, birds that had been blinded in only one eye, we believe that this merely indicates that the roup was less severe in those cases, which was the cause at the same time of the slight affection of the eyes and of the bird's recovery.

In 1901 R. J. Weith, of Elkhart, Ind., reported that he was confident that 10,000 crows died within a radius of 2 miles of that place, due, probably, to an epizootic of "roup."[1]

The late Prof. F. E. L. Beal related having seen birds at the roost near Langdon, D. C., affected by this disease in the winter of 1901. Several hundred birds, partially or totally blind, were noticed aimlessly pecking at branches and running their bills along them in a fruitless endeavor to find food. These birds were too seriously affected to accompany their companions on their daily search for food.

The writer has witnessed mild outbreaks of this disease at the Langdon (D. C.) roost during the four winters from 1911–12 to 1914–15. In each year a few score of birds were found dead. All the sick birds which were kept in captivity and forcibly fed died within three or four days. During the winter of 1913–14 the disease was prevalent among crows throughout adjacent parts of Maryland and Virginia.

In the reduction of the number of crows by natural agencies no other single factor appears to be so potent as this disease. Birds that do not succumb are often so enfeebled that their capture by predatory animals is comparatively easy.

PROTECTION OF CROPS.

The ravages of crows upon fields of grain and other crops have been matters of record almost from the beginning of agricultural activities. Before the advent of firearms and the use of poisons and deterrents of various kinds the protection of crops was intrusted entirely to "grain minders," whose constant presence in the fields during all hours of daylight was necessary. When the early colonists attempted to cultivate limited areas of corn and other grain along the Atlantic slope, they found themselves confronted with many of the same problems that had occupied their attention in Europe. The American crows became as troublesome as the rooks, hooded crows, and jackdaws had been in their former homes. Some of the landowners, especially those in the southern colonies, still resorted to the "grain minder"—the negro children in many cases being thus employed. At the same time various mechanical devices came to be used to do the tedious work, and experiments, which doubtless had their origin in Europe in the use of certain deterrents applied to the seed grain, also were tried, thus making the crops in question at least partially immune to the attacks of these birds. Several of these deterrents have proved effective and by their use many farmers have reduced in large measure their annual losses from crows.

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[1] Country Gentleman, LXVI, 2520, pp. 412–413, 1901.

FRIGHTENING DEVICES.

It is not necessary to describe in detail the many well-known devices employed as "scarecrows." These include the time-honored straw-stuffed human effigy; various unusual objects, as pieces of shining tin moving in the wind, glass bottles, windmills which operate noise-producing mechanisms, ears of corn and newspapers placed on the ground; twine stretched about and across the fields from poles placed at intervals; and bodies of dead crows hung in conspicuous places. One or another of these contrivances has brought the desired results on occasions, but all have failed at other times. None can be considered infallible.

DETERRENTS.

Much of the damage to corn and other grains is at sprouting time. The difficulty, however, has been met fairly well by the application of deterrents upon the seed. Experiments along this line have been made for many years and as early as the beginning of the nineteenth century methods had been perfected. Even at that time several different substances had been used to coat the seed. The most successful involved the use of coal tar. Since these early experiments many other methods and formulas embodying the use of tar have been devised. These, however, varied but little and aimed merely to secure an even and thorough coating of the seed, which was followed by a drying process either by spreading the grain or by the application of some drying medium, as lime, ashes, or land plaster.

A few years ago the Kansas State Agricultural College Experiment Station conducted a series of experiments to ascertain the usefulness of certain deterrents on seed grain against burrowing animals. Incidentally the effect of these various substances upon the germinating powers of the seed was investigated. In a report[1] on this work, Theo. H. Scheffer stated in part:

> Kerosene, crude petroleum, copperas, crude carbolic acid, fish oil, and spirits of camphor, when used in sufficient quantity or strength to impart an odor to the corn, seriously injure the germinating powers of the grain. To treat the

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[1] Circ. 1, Kansas State Agr. Coll. Exp. Sta., p. 3, April 28, 1909.

seed with any of these substances in such small quantity or dilute form as not to injure the germ is a waste of time, for the slight taste or odor imparted is soon dissipated in contact with the soil.

Mixing pulverized gum camphor with the dry grain and storing it in a closed vessel for some days has been recommended as an efficient treatment. With us the results were entirely negative. Little or no odor was imparted to the grain. Pine tar was used in our experiments. It has a strong odor, but leaves the grain too sticky to work in a planter.

Coal tar makes an ideal coating of a rich brown color and a persistent, gassy smell. It dries nicely, is not in the least sticky, and will work well in a planter. Wet the grain with a little warm water before stirring in the tar. A teaspoonful of the latter will be sufficient for a peck of corn. The mass must be thoroughly mixed and then dried before attempting to plant.

Valuable experiments showing the effect upon seed grain of the various deterrents against crows were conducted by B. M. Dugger and M. M. McCool at the Agricultural Experiment Station of Cornell University. The following is an extract from their report:[1]

Considering the practices now more or less commonly employed, it seemed desirable to give the coal tar a careful experimental trial, and, at the same time, to employ other substances with objectionable odors or tastes. Accordingly, experiments were arranged for the treatment of seed with the following substances, namely, coal tar, pine tar, oil of turpentine, anilin oil, and pyridine. * * *

Some difficulty was anticipated in securing a more or less equal distribution of the small amount of tar upon so large a volume of seed, but it was found that this could be accomplished by repeated stirring or shoveling of the seed. Tar at the rate of one or two tablespoonfuls per 10 quarts of seed was sufficient effectively to coat almost every seed in the mass. This was true in the case of both the coal and the pine tars. It was therefore evident that any of the materials mentioned could be employed so far as convenience is concerned. In employing pyridine and anilin oil 10 per cent solutions were used, and with turpentine a 10 per cent emulsion. In these solutions the seeds were soaked for a period of two or three hours.

After treatment the seeds were sown in pots containing a sandy loam soil, this in order to determine the effect of the treatment given upon germination.

The results of this germination test showed that seed treated with pine tar, coal tar, and pyridine solution (three hours) gave the most favorable results—a germination of between 98 and 100 per cent, which was equal to that of the untreated seed used as a check. Turpentine emulsion (three hours), turpentine emulsion (four and one-half hours), and anilin oil solution (three hours) gave percentages of 38, 8, and 0, respectively. The report continues—

The results of these experiments demonstrate conclusively, it would seem, that the use of tar in no way prevents germination. It might be further stated that germination was not retarded by the use of tar in the experiments above mentioned. Again, varying quantities of the tars were also employed with similar results. In other experiments the seeds were planted in moist paper and com-

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[1] Circ. 6, Cornell Univ. Agr. Exp. Sta., pp. 14–16, May, 1909.

> pared with control experiments under similar conditions. In no case was any injury by the tar demonstrated. The same results were secured when the treated seeds were spread out and permitted thoroughly to dry before being planted. * * * Some surprise, however, was felt at the result of the use of turpentine, for the experiments demonstrated that a protracted treatment with this substance is extremely injurious. * * *
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> Corn freshly treated with either of the tar preparations could not be employed in the corn planter without experiencing great difficulty in uniformly dropping the seed. On the other hand, it is found that when properly spread on the dry floor the treated corn will completely dry out in a few days so that it may be used without difficulty in a planter. According to the experience of others a quart or two of fine land plaster or sifted ashes may be mixed with the seed immediately after the tar treatment, and the treated seed may in this way be used immediately without serious inconvenience. In this case it would perhaps be wise to use a minimum amount of tar.

Reference is then made in the report to similar and more extensive experiments conducted at the Illinois Agricultural Experiment Station,[1] which produced the same favorable results in respect to use of coal tar.

These various experiments demonstrated conclusively that the use of coal tar according to the formulas and methods stated is in no way injurious to the seed itself. Germination, however, is delayed slightly even under conditions favorable to growth, and in times of drought this delay may be two or three days.

That the process of treating the seed with tar has met with favorable results in deterring crows from the sprouting grain in this country has been demonstrated repeatedly by many practical farmers. It appears from the mass of correspondence received from those acquainted with modern farm methods and practices throughout the country that the tarring of seed grain is most extensively practiced in the North Atlantic States. Though a vastly greater amount of corn is raised in the States of the upper Mississippi Valley, seed corn is seldom tarred there. From the same reports it is learned that, when properly done, tarring has almost always proved successful and, beyond the pulling of a few spears of grain (enough to get a taste of the tar), the crows usually inflicted no further damage.

Accordingly, it may be recommended that coal tar used at the rate of about a tablespoonful to a half bushel of seed grain, which has been previously heated with warm water, and then drained, is a fairly successful crow deterrent. A continued stirring of the grain will eventually permit an even coating of tar. The seed must then be spread on a dry surface, or drying may be facilitated by the application of some absorbent medium, such as ashes, land plaster, or powdered earth. When thoroughly dried the grain may be used in a planter. Coal tar is a cheap by-product in the manufacture of illuminating gas and may be procured at gas works or paint shops.

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[1] Forbes, S. A., Bull. 130, Ill. Agr. Exp. Sta., Dec. 1908.

The manufacture of deterrents for use on seed grain has been undertaken on a moderate scale in this country, and a few articles of this nature also have been imported. Most of these appear to contain coal tar or closely related products as a base, while at least one of the imported deterrents is a dye. There is no evidence that any of these manufactured substances is superior to coal tar when the latter is properly applied.

Some success has been attained with red lead for the same purpose. This deterrent has been used in Europe for some time, but in this country its use has been confined to recent years. A method of applying the red lead with the aid of a glue size has been suggested by a Pennsylvania farmer:[1]

> One-half pound of glue was dissolved in 1 quart of warm water and when dissolved 5 or 6 quarts of warm water was added. Into this, corn, enough to be covered by the liquid, was added. The excess of liquid was then drained and red lead was added until well colored.

Though this process has been little used in this country, its success in deterring birds in Europe warrants further trial.

SCATTERING OF GRAIN.

Many farmers have had considerable success in protecting their sprouting crop by spreading broadcast over fields a quantity of grain previously softened with water. This the birds take and leave untouched that which has been planted. It has been found that a comparatively small amount sacrificed in this way has often prevented loss to the growing crop.

POISONING.

Though it would be most difficult to eradicate the crow over any considerable area by a campaign of poisoning, due largely to the bird's wariness, this method has been found effective in protecting crops. When once a flock of these birds have learned, through the loss of one or more of their number, that a certain area has been well baited with poisoned food, they are inclined to avoid it for some time at least. But as there is always an element of danger connected with the distribution of poison in thickly settled regions, its use should be limited and judicious.

Corn is generally employed as a bait in poisoning and it is usually prepared by simply steeping in a strong strychnin solution. If the poison is made, however, according to the following recipe it will kill more quickly and its effectiveness will last for a considerable time even when exposed to weather:

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[1] Rural New Yorker, LXI, 2727, p. 345, 1902.

Corn	20 quarts.
Strychnin (powdered)	1 ounce.
Starch	2 tablespoonfuls.
Water	1½ pints.

Mix the starch and strychnin in the water and heat to boiling, stirring thoroughly after the starch begins to thicken. Pour this mixture over the corn and stir till every kernel is coated. The corn may then be spread out and dried.

Successful results also have been obtained by the use of partially blown hens' eggs into which a small quantity of strychnin has been injected. These should be placed on the tops of stacks or in inclosures from which poultry and all farm animals are barred. Carrion or meat of any kind is another convenient and efficient medium for the poison. Such bait works best in winter when the birds are hard pressed for food.

TRAPPING.

Trapping has brought relief at times when other methods have failed. No wholesale reduction in the number of crows has ever been accomplished by this method, but when once a few of these birds are trapped and their dead bodies hung up about the fields their relatives are inclined to shun the immediate vicinity. These birds have been secured mainly in steel traps carefully concealed and baited with hens' eggs.

SHOOTING.

Continued persecution of crows with firearms has at times brought relief from their depredations, but the unusual wariness of these birds has made this method of killing them difficult. The use of crow decoys and crow "calls" to attract them within gunshot has been resorted to with more or less success. Placing a stuffed owl in a conspicuous place and within easy gunshot has been successful in luring number of crows to a point where they can be shot.

Writing of the fish crow in this connection, Louis A. Zerega states:[1]

> Mr. Keller shot most of the specimens that were killed by him from the cover of a "blind" over "decoys" (which are simply pieces of blackened pasteboard of bird shape, set up at different angles so as to present a side toward each direction). As the crows fly over they see the "decoys" and, supposing the place to be a good feeding ground, fly toward it; I have even seen common crows alight before discovering their mistake.

Frank M. Chapman gives an interesting account[2] of an attack made by crows upon a mounted barred owl. After placing the mounted bird in a favorable place and carefully concealing himself he gave the call of the barred owl and—

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[1] Bull. Nuttall Orn. Club, V, No. 4, p. 206, October, 1880

[2] Bird Lore, XI, No. 1, p. 4, January-February, 1909.

> in a moment or two the expected response came from a neighboring wood, and very shortly the usual throng of crows had gathered at the part of the woods nearest to the tree in which I was concealed * * *. For some time * * * they circled overhead in winged reconnaissance until one of the birds actually saw the mounted owl in the tree below. Caution was at once abandoned, and, uttering the battle cry of his kind, he, with his fellows, advanced to the attack. A dozen or more of the birds took up positions in or near the tree in which the owl sat so calmly * * *.

Justus von Lengerke, writing to the Biological Survey, says that hundreds of crows are killed in spring and fall by using great horned owls to decoy them to the gun, thus giving the farmers within a radius of several miles much relief from the crow nuisance.

Regarding the use of crows in place of other live birds or "clay pigeons" in trap shooting, Henry W. Foster, of the Philadelphia Academy of Natural Sciences, stated in a recent communication:

> Many crows have been trapped and used for shooting, including both species, but, so far as my meager observations go, the practice does not seem to have diminished their number.

In the same connection, Mrs. George S. Morris, of Olney, Philadelphia, Pa., has written that about 15 years ago great numbers of crows were caught and used in place of pigeons for trap shooting. This was kept up for several years and had a distinct effect on their numbers. To capture crows for use in this way a dead horse or cow was placed in a field as a bait. When the crows had assembled on the carcass in great numbers a net, operated from a distance by a cord, was sprung over them.

The possibilities of crow shooting as a means of sport have appeared so favorable, as well as so fitting a way to reduce the number of these birds in restricted areas, that crow decoys and "calls" have been manufactured and placed on the market.

The systematic destruction of crows' nests has frequently brought about desirable results in farming communities where woodlands border the fields in which tempting crops are raised. This procedure also has been adopted successfully in cases where the parent birds habitually visit some particular poultry yard in search of eggs or young chicks. In winter, when these birds gather in large numbers at their roosts, raids by gunners for several successive nights usually cause them to move on. In thickly settled areas where the discharge of firearms would be inadvisable Roman candles shot among the roosting birds should bring about the same result.

In summing up it must be said that, with the possible exception of the protection of sprouting grain by means of deterrents, no single method for the protection of crops against crows can be considered infallible. Such local conditions as the proximity of their nests or roosts, abundance of natural food supply, availability of cultivated crops, and the varying boldness of these birds in different localities are factors requiring varying methods of control. A sure preventive of losses from crows in one locality often utterly fails in another, and likewise a method of protection may work admirably for a time only to fail completely when once the birds become acquainted with it or learn to avoid its consequences.

LEGISLATION.

In the game laws of most of the Western States, where the crow is too scarce to be of great economic importance, its name does not appear among the exceptions to protection, where in other parts of the country it is usually listed. The crow is thus protected in Arizona, California, Colorado, Idaho, Nebraska, Nevada, New Mexico, Utah, Washington, and Wyoming. In some of these States, however, provision is made whereby the owner of crops subject to injury by crows may kill these birds when they are doing damage. Of the Eastern States, Delaware is the only one in which absolute protection is afforded, no provision being made for the destruction of crows under any circumstance; while in the remaining States the crow is either specifically exempted from protection or is allowed to be shot by the owner or lessee of property on which it is doing injury.

Wherever crows have been troublesome the enactment of bounty laws for their control has been common. Rewards for the destruction of the birds have been offered by States, counties, townships, and in some instances by communities of farmers or by sportsmen's associations. Among the earliest laws enacted by the colonial governments were those dealing with the reduction of crows by bounties, and a perusal of recent statutes will show that this method is still popular.

In 1904, Rhode Island passed a bounty law which provided for the payment of 25 cents apiece for crows and certain birds of prey. Indiana authorized, in 1911, a bounty of 10 cents a head for the birds and 5 cents an egg in lots of not less than 10. All counties in Kansas pay 5 cents for the birds and 1 cent apiece for the eggs. West Virginia allows 10 cents apiece for the birds. Illinois, Maryland, Minnesota, North Carolina (one county), and Wisconsin also have had bounty laws in effect within the last nine years. Most frequently payments are optional with the counties, although in some cases, as in Kansas, it is mandatory.

At times the management of game preserves or farms offers rewards for the destruction of these birds in the immediate vicinity of reservations. In this connection Jonathan B. Gadsden, manager of the Oakland Club, in South Carolina, has written: "I pay 10 cents for the bill of every crow, but can honestly say I see no great benefit nor any decrease in numbers." (1912.)

A. W. Perrior, of Syracuse, N. Y., states that "the Anglers' Association of Onondaga County offered a bounty of 5 cents a head three years ago but there were very few heads brought in, due to the fact that the price offered was too small." (1912.)

Notwithstanding the popularity of the bounty system, it has several objectionable features which make it not only unsatisfactory, but also dangerous. Its efficiency in reducing the number of crows over large areas is to be seriously questioned, inasmuch as the comparatively small sum which can be offered does not often furnish a sufficient incentive for a persistent warfare of extermination. At the same time the opportunities and incentives for fradudulent practices are numerous.

In many localities in which bounties have been paid more or less continuously for many years, crows are still found in considerable numbers, and, judging from the amounts being paid from year to year for bounties, the birds do not appear to be in immediate danger of extermination. The numbers of crows have been reduced to some extent in comparatively restricted areas when bounties were reasonably attractive. On the other hand, cases have come to attention where the numbers have actually increased in areas where bounty laws were in force.

To enter into a discussion of the various ways in which bounty laws have led to fraudulent practices would extend this bulletin beyond its legitimate scope. It will suffice to say that bounty systems against crows will continue to result in meager returns for the money invested as in the past, and at the same time will be liable to produce conditions savoring of the iniquity with which so many of these systems have been associated.

SUMMARY.

A brief summary of decisions reached respecting each of the more important economic problems that have arisen in this investigation will make it possible to review with some degree of thoroughness the many-sided question of the value of the crow.

FOOD HABITS.

INSECTS.

The crow's destruction of insects presents the strongest argument in the bird's favor. Nearly a fifth of the adult crow's yearly sustenance comes from such sources, and a great part of the insect material is eaten early in spring, a time when the life cycles of many of the most destructive pests are at their lowest ebb. A little later, nestling crows appear on the scene, outnumbering their parents two to one, and assist in the work of destruction. Not only do the young birds eat a much larger proportion of insect food than do their parents at the same time of year, but the quantity of food required to develop their rapidly growing bodies is considerably greater. That injurious insects greatly outnumber beneficial insects in the diet of the crow will be seen from the following review of the four most important orders:

Beetles.—The crow's relation to beetles is all that the frugal agriculturist could desire. Foremost among these insects in its food are May beetles and their destructive larvæ, white grubs. These, with a few other phytophagous scarabæids and scavengers of the same family, as disclosed by stomach examination, totaled over half the beetles eaten. The destruction of a few click beetles, weevils, and wood-boring beetles also must be considered in the bird's favor. Ground beetles, most of which are beneficial, made up about a fifth of the beetle food and must be charged against the crow. Coprophagous and necrophagous forms eaten, as Silphidæ and Staphylinidæ, are slightly beneficial.

Grasshoppers.—In its consumption of grasshoppers the crow renders man its most important service. In regions where these decidedly injurious insects are abundant their nymphs form the principal insect-food of nestlings. Not only do the food habits of these young birds exert a strong control on the increase of grasshoppers, but the destruction of these insects is accomplished so early in the season that it has the added effect of preventing much of the damage which would be inflicted if the work were delayed till later in the year.

Caterpillars.—In its consumption of caterpillars the nestling crow exceeds its parent in effectiveness in the ratio of about 4 to 1. This food, found in over a third of the stomachs of young crows, is all in the bird's favor, especially since cutworms constitute the major portion.

True bugs.—Among the true bugs, only soldier bugs (Pentatomidæ) and the periodical cicada are worthy of mention in this summary. The former, taken in small quantities on numerous occasions, embrace both predacious and herbivorous species, an indiscriminate destruction of which must be largely neutral in effect. The destruction of the periodical cicada must also be considered of minor economic importance.

SPIDERS.

The exact economic status of the large wolf spiders (Lycosidæ), which comprise the major part of the arachnid food of young crows, is not satisfactorily known. The fact that they are terrestrial in their feeding eliminates from their diet many of the injurious plant-feeding and flying-insect pests, while most of the beneficial, predacious forms are subject to their attack. Thus their destruction by the crow can be considered only partially prejudicial to the interests of man.

Crustaceans

The consumption of crustaceans must be classed among the minor benefits conferred by the crow. While much of this food is picked up as carrion along beaches or river banks, a considerable number of crawfish fall as the crow's prey in portions of the South where these creatures are abundant and destructive.

Reptiles and Amphibians.

Feeding on the smaller snakes and lizards must be charged against the crow, but by the destruction of a few larger, more or less arboreal serpents the bird compensates for some of its own misdemeanors against nesting birds. While it is impossible to determine the exact extent of the crow's predacious activities against the larger snakes, it follows that in the consumption of any such material the bird confers a benefit either as a carnivore or scavenger. Most of the large turtles eaten probably are carrion, while the smaller ones are frequently captured alive.

The crow's destruction of the highly insectivorous amphibians, especially toads and frogs, is to be deplored. Such work is opposed to the best interests of man, but, fortunately, toads, which come most intimately in contact with insect pests of garden and field, are less frequently eaten than frogs.

Wild Birds and Their Eggs.

The crow's destruction of wild birds and their eggs is a noxious trait of no small importance. It is somewhat mitigated, however, by the fact that most of the depredations on eggs occur early enough in the season to permit the raising of a second brood at a time when there is little or no danger from crows. To this fact alone can be attributed the ability of some waterfowl to maintain their numbers in regions where they are regularly subject to attack. The destruction of nestling birds of highly beneficial species is not to be condoned and constitutes one of the strongest arguments against the crow. On game farms, preserves, and in suburban districts where it is the desire to foster small birds, the crow population must be kept within limited numbers. Sufficient cover also must be left for woodland game birds.

Poultry and Their Eggs.

The molesting of poultry by the crow is an injurious habit against which protective measures are effective under any but the shift-by-itself method of caring for fowls. A little attention to the screening of young chicks and the suitable housing of nesting fowls will obviate most losses of this kind. The trait appears to be one of the individual crow working under favorable conditions. In breeding time, when most losses of this kind are suffered, the destruction of a single near-by nest of young crows will often put a stop to the nuisance.

Small Mammals.

Inasmuch as most of the small mammals destroyed by the crow are rodents, the bird's activities in this direction are mainly beneficial.

Annoyance of Live Stock.

The molesting of such live stock as young lambs and swine, an occasional habit of the crow when hard pressed for food, is to be condemned. Fortunately such work is not common, and the aggregate loss of this kind is negligible.

Carrion.

In the Southern States the crow ably supplements the work of the turkey buzzard as a carrion feeder, while in the interior portions of the North he is the principal scavenger among the land birds.

Corn.

Corn is the principal food of the adult crow. It is eaten in every month of the year, and from October to January forms over half the bird's diet. Much is waste grain, but in sprouting time and when corn is "in the roasting ear," and even when it is ripe and standing in the shocks the crow inflicts damage. Deterrents, as coal tar, on the seed have greatly lessened losses of newly sown grain, though the crow still reaps considerable toll. When "in the roasting ear" the corn crop is especially subject to most annoying attacks, and for this there is no effective remedy. The ripened grain seems less palatable, and, while a large quantity is eaten, it is apparently taken more from necessity than choice. Prompt harvesting of the crop will greatly reduce such losses.

Other Grain.

Damage to wheat and oats is confined mainly to sowing and sprouting time, and is by no means so universal or serious as the pilfering of sprouting corn.

Miscellaneous Crops.

Melons, especially watermelons, are at times considerably damaged by the crow in southern States; small fruits occasionally are attacked; and still more rarely crops of cultivated nuts and garden truck are levied upon.

DISTRIBUTION OF LIVE-STOCK DISEASES.

As a distributor of disease the crow, along with the turkey buzzard, has been a target for much unjust criticism. While the crow may be an agent in the transmission of live-stock diseases, it does not follow that even the extermination of this species would materially lessen the danger of infection. As the agencies at work in the transmission of virus are many and difficult of control, the elimination of but one would aid little. Inoculation and the strictest sanitation and quarantine are the farmer's strongest weapons in the fight against such epizootics.

DISTRIBUTION OF SEEDS.

The crow's consumption of wild fruit in itself involves nothing of economic interest, as the embryos of the seeds eaten are seldom destroyed, but as this material is regurgitated after the digestible portion has been assimilated it is apparent that the crow thereby becomes an agent in the dispersal of seeds. When engaged in the distribution of seeds of valuable or even harmless trees and shrubs, the crow is conferring a benefit; but when it assists in the spread of such noxious plants as poison ivy and poison oak, the opposite interpretation must be given. Since, however, numerous other birds have the same objectionable habit, the crow's consumption of such seeds has a limited influence for good; the large quantity it devours doubtless reduces the supply available for other species which do not deposit so large a percentage of the seeds in places where they will never sprout as does the crow.

CONCLUSION.

When feeding on injurious insects, crustaceans, rodents, and carrion, and when dispersing seeds of beneficial plants, the crow is working largely for the best interests of man; when destroying small reptiles, amphibians, wild birds, poultry, corn, and some other crops, when molesting live stock and distributing their diseases, and when spreading seeds of noxious plants, the bird is one of the farmer's enemies; when destroying spiders and mollusks, however, its work appears in the main to have a neutral effect. The misdeeds of which the crow has been convicted greatly outnumber its virtues, but these are not necessarily equal in importance. Much of its damage to crops and poultry can be prevented, while the bird's services in the control of insect pests can ill be spared. At the same time no policy can be recommended which would allow the crow to become so numerous that its shortcomings would be greatly accentuated. As the capabilities of the crow for both good and harm are great, it is believed that an extermination of the species would have ultimate consequences no less serious than an overabundance.

Inasmuch as this investigation aimed at reaching general conclusions respecting the status of the crow, in order that our attitude toward the bird might be based on sound economic principles, it may be said that the laws relating to it, at present in force in most States, are altogether satisfactory. It is well that no protection be afforded the bird and that permission be granted for shooting it when it is actually found doing damage. Bounties can not be recommended, neither can a campaign of wholesale destruction where complete extermination is the object sought. However, a reasonable reduction of numbers is justifiable in areas where there is an overabundance of the birds. The attitude of the individual farmer toward the crow should be one of toleration when no serious losses are suffered, rather than one of uncompromising antagonism resulting in the unwarranted destruction of these birds which at times are most valuable aids to man.

LIST OF ITEMS SPECIFICALLY OR GENERICALLY IDENTIFIED IN THE 2,118 CROW STOMACHS EXAMINED.

NEMATODA.

Gordius sp.

ANNULATA.

Nereis sp.
Lumbricus sp.

CRUSTACEA.

Crangonyx sp.
Armadillidium sp.
Porcellio sp.
Cambarus sp.
Emerita talpoida.

MYRIAPODA.

Julus cœruleocinctus.
Polydesmus sp.

INSECTA.

COLEOPTERA.

Cicindela punctulata.
Cicindela purpurea.
Cicindela repanda.
Cicindela 6-guttata.
Cicindela scutellaris.
Cicindela unipunctata.
Cicindela vulgaris.
Omus sp.
Tetracha virginica.
Agonoderus pallipes.
Amara pennsylvanica.
Amara polita.
Amara fallax.
Anisodactylus agricola.
Anisodactylus baltimorensis.
Anisodactylus carbonarius.
Anisodactylus rusticus.
Anisodactylus sericeus.
Anisodactylus terminatus.
Anisodactylus verticalis.
Bembidium sp.
Brachynus sp.
Calosoma calidum.
Calosoma cancellatum.

Calosoma externum.
Calosoma luxatum.
Calosoma scrutator.
Calosoma tepidum.
Calosoma willcoxi.
Carabus mæander.
Carabus serratus.
Carabus sylvosus.
Carabus vinctus.
Casnonia pennsylvanica.
Chlænius æstivus.
Chlænius impunctifrons.
Chlænius laticollis.
Chlænius nemoralis.
Chlænius niger.
Chlænius pennsylvanicus (?).
Chlænius sericeus.
Chlænius tomentosus.
Chlænius tricolor.
Cratacanthus dubius.
Cychrus elevatus.
Cychrus marginatus (?).
Cychrus stenostomus.
Cymindis pilosa.
Dicælus furvus.
Dicælus purpuratus.
Elaphrus ruscarius.
Evarthrus sodalis.
Galerita lecontei.
Geopinus incrassatus.
Harpalus amputatus.
Harpalus basilaris.
Harpalus caliginosus.
Harpalus erraticus.
Harpalus herbivagus.
Harpalus lewisii.
Harpalus pennsylvanicus.
Harpalus vagans.
Harpalus viridiæneus.
Loxandrus sp.
Nothopus grossus.
Panagæus fasciatus.
Pasimachus depressus.
Pasimachus elongatus (?).
Pasimachus marginatus.
Pasimachus punctulatus.
Patrobus longicornis.
Platynus crenistriatus.
Platynus cupripennis.
Platynus cupreus.
Platynus melanarius.
Platynus punctiformis.
Pterostichus coracinus.
Pterostichus lucublandus.
Pterostichus patruelis.
Pterostichus sayi.
Pterostichus stygicus.
Scarites subterraneus.
Scarites substriatus.
Colymbetes sculptilis.
Cybister sp.
Dytiscus verticalis.
Rhantus binotatus.
Hydrobius globosus.
Hydrocharis obtusatus.
Hydrophilus triangularis.
Tropisternus glaber.

Tropisternus nimbatus.
Sphæridium scarabæoides.
Necrophorus americanus.
Necrophorus marginatus.
Necrophorus pustulatus.
Silpha americana.
Silpha inæqualis.
Silpha lapponica.
Silpha noveboracensis.
Silpha ramosa.
Silpha surinamensis.
Bledius sp.
Creophilus villosus.
Lathrobium sp. (?).
Listotrophus sp.
Staphylinus cinnamopterus.
Staphylinus maculosus.
Staphylinus mysticus.
Staphylinus tomentosus.
Staphylinus viridans.
Staphylinus vulpinus.
Megilla maculata.
Silvanus surnamensis.
Dermestes sp.
Hister abbreviatus.
Hister americanus.
Hister cognatus.
Hister depurator.
Hister fœdatus.
Hister instratus.
Hister merdarius.
Hister sexstriatus.
Platysoma sp.
Saprinus lugens.
Stelidota geminata.
Byrrhus americana.
Cytilus sericeus.
Dryops lithophilus.
Heterocerus sp.
Agriotes mancus.
Alaus oculatus.
Anchastus sp. (?).
Asaphes decoloratus.
Corymbites æthiops (?).
Corymbites æripennis.
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Dolopius sp. (?).
Drasterius elegans.
Glyphonyx sp.
Limonius griseus.
Limonius plebejus.
Melanactes morio.
Melanactes piceus.
Melanotus marginatus.
Melanotus scrobicollis.
Monocrepidius sp.
Brachys ærosa.
Buprestis fasciata.
Buprestis striata.
Chalcophora virginiensis.
Chrysobothris femorata.
Dicerca obscura.
Dicerca lurida.
Photuris pennsylvanica.
Telephorus sp.
Collops sp.
Sitodrepa panicea.

Ceruchus piceus.
Dorcus parallelus.
Lucanus dama.
Passalus cornutus.
Anomala binotata.
Anomala lucicola (?).
Anomala varians.
Aphodius fimetarius.
Aphodius fossor.
Aphodius granarius.
Aphodius inquinatus.
Aphodius lividus.
Aphodius pardalis.
Aphodius ruricola.
Atænius cognatus.
Atænius cylindrus (?).
Bolboceras lazarus.
Bolbocerosoma farctum.
Canthon chalcites.
Canthon lævis.
Canthon simplex.
Chœridium histeroides.
Copris anaglypticus.
Copris minutus.
Cotalpa lanigera.
Cotinis nitida.
Cremastochilus knochii.
Dialytes striatulus.
Dichelonycha albicollis (?).
Diplotaxis tristis.
Dynastes sp.
Dyscinetus trachypygus.
Euphoria fulgida.
Euphoria inda.
Euphoria sepulchralis.
Geotrupes balyi (?).
Geotrupes blackburnii.
Geotrupes egerei.
Geotrupes semiopacus.
Geotrupes splendidus.
Hoplia trivialis.
Pinotus carolinus.
Phyllophaga anxia.
Phyllophaga barda.
Phyllophaga crassissima.
Phyllophaga crenulata.
Phyllophaga drakii.
Phyllophaga fervida.
Phyllophaga forsteri.
Phyllophaga fraterna.
Phyllophaga fusca.
Phyllophaga futilis.
Phyllophaga hirsuta.
Phyllophaga hirticula.
Phyllophaga hornii.
Phyllophaga ilicis.
Phyllophaga implicita.
Phyllophaga marginalis.
Phyllophaga profunda.
Phyllophaga rubiginosa.
Phyllophaga rugosa.
Phyllophaga tristis.
Phyllophaga vehemens.
Ligyrus gibbosus.
Ligyrus relictus.
Macrodactylus subspinosus.
Ochodæus sp. (?).

Onthophagus hecate.
Onthophagus pennsylvanicus.
Osmoderma eremicola (?).
Pelidnota punctata.
Phanæus carnifex.
Polyphylla sp.
Serica vespertina.
Strategus antæus.
Trichius piger.
Trox asper.
Trox suberosus.
Xyloryctes satyrus.
Acmæops subpilosa.
Anthophilax malachiticus.
Clytanthus ruricola.
Desmocerus palliatus.
Distenia undata.
Leptura vittatus.
Monilema annulatum.
Monohammus scutellatus.
Monohammus titillator.
Tetraopes sp.
Toxotus cinnamopterus (?).
Toxotus schaumii (?).
Typocerus lunatus.
Calligrapha elegans.
Chætocnema denticulata (?).
Coptocycla sp.
Crepidodera helxines.
Donacia pulsilla (?).
Gyptoscelis sp. (?).
Myochrous denticollis.
Typophorus canellus.
Physonota unipunctata.
Systena elongata.
Spermophagus robiniæ.
Asida sp.
Coniontis ovalis.
Eleodes letcheri.
Eleodes tricostata.
Epitragus tomentosus.
Eusattus muricatus.
Helops cisteloides.
Opatrinus aciculatus.
Opatrinus notus.
Iphthimus opacus.
Meracantha contracta.
Paratenetus punctatus.
Cantharis sp.
Meloe angusticollis.
Thecesternus humeralis.
Anametis granulatus.
Epicærus imbricatus.
Eupagoderes sp.
Glaphyrometopus ornithodorus.
Hormorus undulatus.
Melamomphus luteus.
Otiorhynchus sulcatus.
Tanymecus confertus.
Chalcodermus æneus.
Conotrachelus posticatus.
Hylobius pales.
Hyperodes sp.
Lepyrus geminatus.
Listronotus appendiculatus.
Listronotus caudatus.
Lixus concavus.
Pachylobius picivorus.
Hypera punctata.
Rhyssematus lineaticollis.
Sitona flavescens.
Sitona hispidula.
Stephanocleonus plumbeus.
Tyloderma foveolatum.
Eupsalis minuta.
Sphenophorus cariosus.
Sphenophorus costipennis.
Sphenophorus germari.
Sphenophorus melanocephalus.
Sphenophorus parvulus.

ORTHOPTERA.

Arphia sp.
Chortophaga viridifasciata.
Dissosteira carolina.
Encoptolophus sordidus.
Gomphocerus clepsydra.
Hippiscus corallipes.
Melanoplus atlanis.
Melanoplus bivittatus.
Melanoplus differentialis.
Melanoplus femur-rubrum.
Schistocerca americana.
Stenobothrus sp.
Tettigidea sp.
Tettix granulata.
Tettix triangularis.
Anabrus simplex.
Ceuthophilus sp.
Conocephalus ensiger.
Cyrtophyllus perspicillatus.
Orchelimum sp.
Gryllotalpa borealis.
Gryllus assimilis.
Nemobius vittatus.

LEPIDOPTERA.

Epargyreus tityrus.
Cressonia juglandis.
Callosamia promethia.
Hemileuca maia.
Tropæa luna (?).
Adelocephala sp. (?).
Apantesis arge.
Diacrisia virginica.
Apatela oblinita.
Agrotis sp.
Feltia subgothica (?).
Alabama argillacea.
Cirphis unipuncta.
Laphygma frugiperda.
Nephelodes violans.
Datana sp. (?).
Crambus sp.
Hemerocampa leucostigma.
Malacosoma americana.
Paleacrita vernata.

HEMIPTERA.

Cicada pruinosa.
Tibicen septendecim.
Vanduzea sp.
Notonecta sp.
Belostoma sp.
Zaitha fluminea.
Pelocoris femoratus.
Apiomerus crassipes.
Fitchia aptera.
Melanolestes abdominalis.
Melanolestes picipes.
Arilus cristatus.
Sinea sp.
Ploiariola errabunda.
Gerris sp.
Blissus leucopterus.
Neides muticus.
Alydus eurinus.
Euthoctha galeator.
Acrosternum hilare.
Ælia americana.
Brochymena sp.
Euschistus servus.
Euschistus variolarius.
Hymenarcys nervosa.
Menecles insertus.
Podisus maculiventris.
Thyreocoris sp.

DIPTERA.

Limnobius sp.
Tipula sp.
Bibio femoratus (?).
Odontomyia sp.
Sargus sp.
Stratiomyia sp.
Tabanus atratus.
Sparnopolius fulvus (?).
Promachus rufipes.
Dolichopus sp. (?).
Gastrophilus sp.
Sarcophaga sp.
Calliphora vomitoria.
Lucilia cæsar.
Prochyliza sp.

HYMENOPTERA.

Lagium atroviolaceum.
Cimbex americana.
Amblyteles sp.
Ophion sp.
Aphænogaster fulva.
Crematogaster lineolata.
Messor sp.
Myrmica brevinodis.
Myrmica rubra.
Solenopsis debilis.
Tetramorium sp.
Dolichoderes mariæ.
Camponotus herculeanus pennsylvanicus.
Formica fusca subsericea.
Formica pallide-fulva schaufussi.
Formica rufa obscuripes.
Formica truncicola integra.
Formica truncicola obscuriventris.
Lasius alienus.
Lasius claviger.
Lasius interjectus.
Mutilla sp.
Tiphia inornata.
Scolia sp. (?).
Odynerus sp.
Polistes metricus.
Polistes variatus (?)
Vespula maculata.
Cryptocheilus sp.
Priocnemis sp.
Psammochares sp.
Astata sp.
Crabro sp.
Halictus sp.
Sphecodes sp.
Andrena sp.
Nomia sp.
Nomada sp.
Megachile sp.
Apis mellifera.

ODONATA.

Epiæscha heros (?).

NEUROPTERA.

Corydalis cornutus.
Chrysopa sp.
Myrmeleon sp.

ARACHNIDA.

Dolomedes sp.
Lycosa carolinensis.
Lycosa punctulata.

MOLLUSCA.

Ostræa sp.
Eurynia parva.
Sphærium sulcatum.
Amnicola limosa.
Melampus bidentatus.
Physa heterostropha.
Planorbis bicarinatus.
Succinea avara.
Bulimus sp.
Helix sp.
Polygyra dorfeuilliana sampsoni.
Polygyra hirsuta.
Polygyra hopetonensis.
Polygyra inflecta.
Polygyra monodon.
Polygyra tridentata.
Euglandina sp.
Gastrodonta suppressa.
Pyramidula perspectiva.
Bittium nigrum (?).
Littorina rudis.

PISCES.

Cyprinus sp. (?).
Hybopsis sp. (?).
Notropis sp.
Semotilus sp. (?).
Lepomis sp.

AMPHIBIA.

Bufo sp.
Hyla sp. (?).
Rana sp.

REPTILIA.

Sceloporus sp.
Zamenis constrictor.
Eutænia sp.
Diadophis punctatus.

AVES.

Bartramia longicauda.
Bonasa umbellus.
Colinus virginianus.
Gallus (domestic fowl).
Melanerpes erythrocephalus.
Sturnella magna (?).
Astragalinus tristis.
Melospiza melodia (?).
Passerina cyanea (?).
Dumetella carolinensis.
Planesticus migratorius.
Sialia sialis (?).

MAMMALIA.

Scalopus sp.
Blarina brevicauda.
Microtus sp.
Mus musculus.
Rattus norvegicus.
Peromyscus leucopus.
Reithrodontomys sp.
Sigmodon hispidus.
Thomomys sp.
Geomys bursarius.
Zapus hudsonius.
Citellus tridecemlineatus.
Sylvilagus floridanus mearnsi.

PLANTS.

Equisetum sp.
Pinus sp.
Juniperus virginiana.
Potamogeton sp.
Andropogon sorghum.
Avena sativa.
Bromus sp.
Chætochloa glauca.
Chætochloa viridis.
Echinochloa crus-galli.
Hordeum sativa.
Melica striata.
Panicum capillare.
Paspalum sp.
Syntherisma humifusa.
Triticum vulgare.
Zea mays.
Zizania aquatica.
Cyperus diandrus.
Eleocharis sp.
Peltandra sp.
Smilax rotundifolia.
Myrica carolinensis.
Myrica cerifera.
Castanea pumila.
Fagus americana.
Quercus sp.
Celtis sp.
Morus sp.
Fagopyrum fagopyrum.
Polygonum arifolium.
Polygonum convolvulus.
Polygonum hydropiper.
Polygonum lapathifolium.
Polygonum pennsylvanicum.
Polygonum persicaria.
Polygonum scandens (?).
Rumex acetosella.
Atriplex sp. (?).
Chenopodium album.
Chenopodium ambrosiodes.
Amaranthus blitoides.
Phytolacca decandra.
Portulaca oleracea.
Agrostemma githago.
Alsine media.
Vaccaria vaccaria.
Ranunculus sp.
Berberis vulgaris.
Brassica napus.
Ribes sp.
Fragaria sp.
Potentilla sp. (?).
Rosa sp.
Rubus strigosus.
Amelanchier canadensis.
Cratægus sp.
Malus malus.
Prunus avium.
Prunus pennsylvanica.
Prunus serotina.
Prunus (cultivated).
Prunus virginiana.
Medicago sp.
Melilotus sp.
Phaseolus sp. (?).
Trifolium pratense (?).
Vigna sinensis.
Oxalis stricta.
Rhus copallina.
Rhus glabra.
Rhus hirta (?).
Rhus radicans.
Rhus vernix.
Ilex opaca.
Berchemia scandens.
Ampelopsis cordata.
Parthenocissus quinquefolia.
Vitis cordifolia.
Malva sp.
Sida sp.
Lepargyrea argentea.
Lepargyrea canadensis.
Cornus alternifolia.
Cornus asperifolia.
Cornus florida.
Cornus occidentalis.
Cornus paniculata.
Cornus stolonifera.
Nyssa sylvatica.
Gaylussacia sp.
Oxycoccus oxycoccus.
Solanum carolinense.
Solanum dulcamara.
Solanum nigrum.
Solanum tuberosum.
Lithospermum sp.
Verbena sp.
Plantago lanceolata.
Diodia teres.
Galium aparine (?).
Mitchella repens.
Lonicera japonica.
Sambucus canadensis.
Sambucus pubens.
Symphoricarpos sp.
Viburnum dentatum.
Citrullus citrullus.
Cucumis melo.
Curcurbita pepo.
Ambrosia artemisiæfolia.
Ambrosia trifida.
Bidens sp.
Helianthus sp.
Taraxacum taraxacum.

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